Advisory Committee on Fishery Management

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REPORT OF THE WORKING GROUP ON NORTH ATLANTIC SALMON

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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1. INTRODUCTION

1.1 Main Tasks

At its 1994 Annual Science Conference, ICES resolved (C. Res. 1994/2:6:19) that the Working Group on North Atlantic Salmon (Chairman: Mr. E.C.E. Potter, UK) should meetat ICES Headquarters from 3-12 April 1995 to consider questions which include those posed to ICES by NASCO. The full terms of reference are listed in Appendix 1 with details of where the questions are answered in the report.

The Working Group considered 25 working documents submitted by participants (Appendix 2); other references cited in the report are given in Appendix 3.

The Working Group also participated in a joint half day meeting with the Baltic Salmon and Trout Assessment Working Group to identify questions of mutual interest and explore possibilities of either merging the two working groups or organising interactions and communication between them. The report of this meeting is in Appendix 4.

1.2 Participants

Anderson, M	Greenland
Baum, E.T.	USA
Caron, F	Canada
Chaput, G.	Canada
Crozier, W.W.	UK (N. Ireland)
Dunkley, D.A.	UK (Scotland)
Eriksson, C.	Sweden
Friedland, K.	USA
Hansen, L.P.	Norway
Holm, M.	Norway
Ikonen, E.	Finland
Isaksson, A.	Iceland
Jacobsen, J.A.	Faroes
Meerburg, D.J.	Canada
O'Maoileidigh, N.	Ireland
Potter, E.C.E. (Chairman)	UK (England & Wales)
Prévost, E.	France
Reddin, D.G.	Canada
Roche, P.	France
Zubchenko, A.	Russia

Addresses of participants are listed in Appendix 6.

2. CATCHES OF NORTH ATLANTIC SALMON

2.1 Nominal Catches of Salmon

Total nominal catches of salmon reported by country in all fisheries for 1960-1994 are given in Table 2.1.1 and nominal catches in homewater fisheries for 1960-1994 are given in Table 2.1.2. Catch statistics in the North Atlantic area also include fish farm escapees and, in the north-east Atlantic, ranched fish (see Section 3). Figure 2.1.1 shows the nominal catch data grouped by area; 'Scandinavia and Russia' includes Denmark, Finland, Iceland, Norway, Russia and Sweden; 'Southern Europe' includes France, Ireland, Spain, UK(England and Wales), UK(Northern Ireland) and UK(Scotland); and 'North America' includes Canada, St.Pierre et Miquelon and USA.

The updated total nominal catch for 1993 of 3,723 t is 418 t lower than the updated total for 1992 of 4,136 t. Total landings for 1993 were the lowest recorded since 1960 and for many countries, catches were lower than the averages of the previous 5 and 10 years. Figures for 1994 (3841 t) are provisional and incomplete, but are already slightly above the 1993 final figure. There is some indication that the numbers of farmed fish may have declined in 1994, but ranched fish still make up a large proportion of the catch in Iceland.

The lack of information on fishing effort presents major difficulties in interpreting catch data for any one year and also in comparing catches in different years. However, it is clear that management plans in several countries have decreased fishing effort and this accounts for some of the decline in catches in recent years.

2.2 Catches in Numbers by Sea-Age and Weight

Reported nominal catches for several countries by sea-age and weight are summarised in Table 2.2.1. As in Tables 2.1.1 and 2.1.2, catches in some countries include both wild and reared salmon and fish farm escapees. Figures for 1994 are provisional and incomplete. Different countries use different methods to partition their catches by sea-age class. These methods are described in the footnotes to Table 2.2.1. The composition of catches in different areas is discussed in more detail in Sections 4 and 5.

2.3 Unreported catches

2.3.1 Unreported catches within Commission Areas

Unreported catches by year and Commission Area, as guess-estimated by the Working Group, are presented in Table 2.3.1. The total unreported catch in 1994 was estimated to be 1276t, a decrease of 22% compared with 1993 and 33% below the 1989-93 five-year mean of 1891 t.

The unreported catch estimated for the North-East Atlantic Commission Area in 1994 was 1,157t, 34% below the five-year mean for 1989-93 of 1747t, and that for the North American Commission Area was 107t, 25% below the 1989-93 mean of 142t. As in 1993, the estimated unreported catch for the West Greenland Commission Area in 1994 comprised the allowable subsistence fishery catch of 12t.

Many of the national estimates are based upon the level of declared catches, and thus the total unreported catch tends to vary in line with the nominal catch figures.

2.3.2 Unreported catches in international waters

Information provided to the Working Group by NASCO indicated that one vessel had been seen fishing in international waters to the north of the Faroes EEZ in 1994 and another was observed preparing to leave port to fish for salmon. One of these vessels is reported to have landed just over 11t after one trip. This is consistent with a similar level of fishing activity in the area to that in recent years. As in previous years, the catch in this area is therefore estimated to have been between 25t and 100t.

3. FARMING AND SEA RANCHING OF ATLANTIC SALMON

3.1 Production of Farmed Salmon

The production of farmed salmon in the North Atlantic area in 1994 was 326,785 t (Table 3.1.1 and Figure 3.1.1). This was the highest production in the history of the farming industry and represented a 22% increase (59,410 t) compared to 1993. Production increased in Norway, UK (Scotland), Iceland and Canada, but there were slight decreases in Faroes, Ireland and USA. The production of farmed salmon now represents about 85 times the nominal catch of wild salmon in the North Atlantic area.

3.2 Production of Ranched Salmon

Table 3.2.1 and Figure 3.2.1 show the production of ranched salmon in countries bordering the North Atlantic. In this context, ranching was defined as the production of salmon through smolt releases with the intent of harvesting the total population that returns to freshwater (harvesting may include collecting fish for broodstock).

According to this definition, there is very limited production of ranched salmon except for commercial ranching operations in Iceland. Production in Iceland in 1994 (308 t) was considerably lower than in 1993 (496 t), although this still represented 69% of the nominal catch. Since 1990, experimental facilities in Ireland, UK(N. Ireland) and Norway have each produced less than 11 t per year, including estimated catches in homewater fisheries. Icelandic catches, on the other hand, are entirely from estuarine and freshwater traps at ranching stations.

4. FISHERIES AND STOCKS IN THE NORTH-EAST ATLANTIC COMMISSION AREA

4.1 Fishing in the Faroes Area

4.1.1 The research programme at Faroes

The Faroese salmon quota has been bought out since 1991. However, the Faroes Government has continued to supervise sampling inside the 200 mile EEZ which has been conducted through a joint Nordic research programme to provide information on salmon in the Norwegian Sea.

The main aims of the project have been:

- to record catches and catch per unit effort, lengths and weights of the fish and the proportion of discards;
- to collect scale samples of salmon in the area, in order to assess smolt age, sea age, and the incidence of farmed fish;
- to assess the migration of wild and farmed salmon by the tagging and release of the two groups, and thereby estimate the proportion of salmon from various countries that use the Norwegian Sea as a feeding area; and
- to provide qualitative and quantitative estimates of the feeding habits of salmon in the Norwegian Sea.

The Working Group supports the continuation of the project outlined above and recognises that the results from the project will improve the possibility of developing reliable assessment models in the North-East Atlantic.

4.1.2 Catches and discards

No commercial fishery took place in 1993/1994. The research fishery followed the normal pattern of previous seasons, beginning close to the islands and moving in a north-easterly direction towards the fishery limit during the season. The total catch in the 1993/1994 season was 7 t and the preliminary catch for the calendar year 1994 was 6 t, excluding fish that were tagged and released (Table 4.1.2.1). All catches were made by the research fishery. The catch in numbers by month is given in Table 4.1.2.2. No fishery took place in January due to bad weather. No research fishing was undertaken outside the Faroes EEZ.

A total of 3,034 fish (including fish tagged and released) was measured of which 436 were less than the permitted

60 cm total length. The discard rate from the catch ranged from 1.5 to 48.6%, and the overall estimate was 14.4% (Table 4.1.2.3). This value is near the upper end of the range observed since the 1982/1983 season.

4.1.3 Catch per unit of effort

The gear in use in the Faroese research fishery did not change in 1994. The fishing effort was low due to the buy-out of the Faroes quota. Only one research vessel operated during the fishing season under supervision of the Faroes Fishery Laboratory. A total of 30 sets was fished by this vessel during 4 trips in the 1993/1994 season.

The catch in number per 1000 hooks (CPUE) by statistical rectangle for the whole season is shown in Figure 4.1.3.1. The CPUE was high in the first part of the season and dropped off in February down to an extreme low figure (13 salmon per 1000 hooks), but increased again to 45 salmon per 1000 hooks in March (Table 4.1.3.1).

The overall CPUE of 43 salmon per 1000 hooks for the 1993/1994 season is the third lowest value since 1981/1982 (Table 4.1.3.1) and was only half the CPUE in 1992/1993 (84), which was the highest in the time series. Possible reasons for the high CPUE in recent seasons were discussed in Anon. (1994a). One of the explanations offered was that the numbers of fish farm escapees had increased. Analysis of scale samples has now confirmed that between 17% and 37% of catches in the last three seasons were of farm escapees (see Section 4.1.4). Figure 4.1.3.2 shows the CPUE for wild and farm origin salmon and shows that the increase in the previous four seasons was due largely to the increase in farmed fish in the area. It is important that scale analysis to identify farm origin salmon continues because the presence of large numbers of reared salmon could mask a decline in the wild stock in the area.

4.1.4 Biological composition of the catch

Some of the basic parameters sampled during the research programme of Atlantic salmon in the long-line fishery at Faroes are listed in Table 4.1.4.1. Salmon were weighed and measured, and scale and stomach samples were taken; the presence of finclips, external tags and CWTs was also recorded. About one third of the fish caught were tagged with external tags and released. Various biological measurements from the research programme at Faroes are discussed below:

Length distribution: The fork length distribution of wild and reared salmon combined (excluding tagged and released fish) is shown in Figure 4.1.4.1. The usual three main length cohorts, representing 1 SW, 2 SW, and 3+ SW fish, are well separated in the catch.

Reared salmon: As a part of the research programme in the Faroese EEZ scale samples were taken to estimate the proportion of reared salmon in the fishery. The method for identification is described by Lund *et al.* 1989; Lund and Hansen 1991). It was estimated that in the 1993/94 season between 15 and 20 % of the fish were of reared origin with an overall estimate of 17 %. Additional results from previous fishing seasons were available to the Working Group, and the time series starting in 1982/83, except the seasons 1983/84, 1984/85, and 1988/89 is shown in Table 4.1.4.2 and Figure 4.1.4.2. The proportion of reared fish in the samples was low until the 1987/88 fishing season, reached a peak in the 1989/90 fishing season and has since declined.

The Working Group has previously noted that the method may identify a small proportion of fish released for ranching and stock enhancement programmes being classified as farm escapees, but the effect of this on the results is not thought to be significant (Anon, 1994a).

Sea age distribution: Prior to the 1991/1992 season, the total catch has been grouped into sea-age classes using length splits (e.g. Anon., 1992) or scale readings of reared and wild fish combined. However, in the 1991/1992 season the sea-age composition was estimated for the proportion of the catch thought to be of wild origin only (including fish < 60 cm) (Anon., 1993a). The sea-age distribution in the 1993/1994 season was estimated in a similar way from the scale samples.

The sea-age distribution of wild fish caught in Nov-Dec and Jan-March is shown in Table 4.1.4.3. The sea age varied between 1 and 3 years in Nov-Dec and 1 and 4 years in Jan-March and the mean sea ages in the two periods were 2.0, and 2.1 years respectively. Table 4.1.4.4 shows the sea-age composition of the research catches (wild fish only) from the 1991/1992 fishing season onwards.

Weight distribution: The weight composition is only available for wild and reared fish combined (Table 4.1.4.5). The increasing trend in the proportion of large fish (> 5 kg) observed in recent seasons (Figure 4.1.4.3), seems to have changed in the 1993/1994 season, mainly due to an increase in the proportion of small salmon (Table 4.1.4.5).

Smolt age distribution: The smolt age composition of the wild fish caught was highly variable between months without any apparent trend. Thus, the samples were grouped for Nov-Dec (n=90) and Jan-March (n=131). In 19% of the scale samples from the wild fish, smolt ageing was not possible because of lack of complete scales or disagreement in classification of annual zones. Among the interpretable samples, smolt age varied between 1 and 4 years in both periods (Table 4.1.4.6). Mean smolt age was slightly lower in the Nov-Dec period (2.5 years) than in the Jan-March period (2.7 years). However, there was no significant difference between the age distribution for the two periods (χ^2= 3,78; df=3; p>0,05). The smolt age distribution (%) of wild fish only (identified by scale reading) for the 1993/1994 season is given in Table 4.1.4.7.

Stomach samples: Preliminary results were available for the analysis of 1272 stomachs was collected in the 1992/1993 season and 1073 in the 1993/1994 season. The stomach contents were analysed qualitatively and quantitatively, and some preliminary results are shown in Tables 4.1.4.8 and 4.1.4.9. The proportion of empty stomachs increased from 24% in 1992/1993 to 31% in 1993/94 (Table 4.1.4.8), and the frequency with which fish species were found in the stomach samples fell from 75% to 41%. As can be seen from the Table 4.1.4.9 both fish and crustaceans are important prey groups for salmon in the sea north of the Faroes. The most important crustaceans were the hyperiid amphipods of the genus *Parathemisto* and Euphasiids. The fishes were mainly lantern fishes and *Maurolicus* sp.

4.1.5 Origin of the catch

The entire catch in the Faroes research fishery was scanned for CWTs and external tags in the 1993/94 fishing season. A total of 19 CWTs was recovered, the majority originating from Irish hatchery reared salmon (Rivers Shannon 5, Bunowen 2, Delphi 1, Burrishoole 2). Of these, 4 were taken from 2SW fish while the remainder were recovered from fish of less than 60cm. The remaining tag recoveries included 6 tags from salmon released in the Selsto River in Norway. These are the first recaptures in the Faroes from the Norwegian CWT tagging programme which began in 1992. Single tag recoveries were also reported from fish originating from the Dee (UK England and Wales), the Hofsa (Iceland) and the Eo (Spain).

A total of 33 external tags was recovered in the Faroes fishery in 1993/1994. Of these recoveries, 30 were recovered from fish originating from Norwegian releases (11 1SW, 18 2SW and 1 3SW). Three tags (2SW) were recovered from fish released in Swedish rivers.

Table 4.1.5.1 gives estimated (or actual) numbers of microtagged fish caught as discards, 1SW and 2SW fish in the Faroes from 1984. As noted in Anon (1994a), the recapture rate per 1,000 smolts released has dropped considerably since the cessation of commercial fishing at Faroes. The highest recovery/1,000 was recorded for Norwegian fish.

Table 4.1.5.2 gives comparative estimates of recapture/1,000 released for CWT and externally tagged fish. These comparisons should be treated with caution as many of the tagged smolts are of hatchery origin and rearing and release conditions may vary greatly between groups; some fish are released as parr. In addition many of the recoveries may not be representative of larger groups or wild fish. However, the data are similar to previous years. The Norwegian CWT recovery/1,000 was similar (0.17) to the value obtained for external tag recoveries in the 1993/1994 season. As in the past, the highest recapture rates were recorded from releases in Norway and Sweden (0.2), followed by Scotland and Faroes. Recaptures rates from other areas are low.

4.1.6 Exploitation Rates at Faroes

The exploitation rates in the Faroes fishery on several stocks from Ireland, Norway, Sweden, UK(N.Ireland) and UK(Scotland) are summarised in Table 4.1.6.1.

Many of the estimates are imprecise as some figures are based on less than 10 tag recoveries. Scandinavian stocks have traditionally been exploited more heavily than stocks from UK or Ireland although relatively high exploitation rates have been recorded on MSW stocks from the North Esk (UK(Scotland)) in the past. Exploitation remains extremely low since the cessation of the Faroes commercial fishery.

In the 1992/93 fishing season, a total of 3050 salmon caught on long-line were tagged with Lea tags and released in the open sea north of the Faroes. In the 1993/94 fishing season only 617 fish were tagged because of low abundance of fish in the area and bad weather during most of the season. In the 1994/95 fishing season an additional 1600 salmon were tagged and released. Thus the total release so far is approximately 5300 fish. Tag recoveries have been reported by commercial fishermen and anglers from home water fisheries.

After two fishing seasons (i.e. 1993 and 1994) 66 tagged fish have been reported recaptured in a total of 10 countries (Table 4.1.6.2) including one fish taken in the Miramichi River in Canada. It should be noted that the number of recoveries is not a direct measure of the relative contribution of stocks to the fishery because tag recovery rates will also be affected by the exploitation rates in the homewater fisheries and the tag reporting rates or catch scanning rates. These results should also be regarded as preliminary because more tag recoveries are expected in forthcoming seasons. Most recaptures (56.1 %) were reported from Norway, and this confirms earlier information that the majority of salmon in the Faroese area originate from Norway. The Working Group also noted that five fish were reported from Russia and that none were recovered in the Faroes research fishery. Preliminary analysis suggests that the recapture rate of farm origin fish is lower than for wild fish, and 17-33 % of the tagged fish were assumed to be of farmed origin.

The recapture rate observed to date is lower than expected. The reason for this might include high post-tagging mortality, reduced exploitation rates in homewater fisheries and low tag reporting rates.

4.2 Homewater Fisheries in the North-East Atlantic Commission area

4.2.1 Gear and effort

The following national reports were provided on changes in gear and effort in homewater fisheries. The numbers of licences issued by gear are given in Table 4.2.1.1.

Finland: No changes in gear were reported for 1994. Effort in the recreational fishery in 1994 decreased slightly from 29,500 in 1993 to 26,500 angler days in 1994. Over the same time period, the number of anglers decreased from 10,200 to 9000.

France: In 1994 both net fisheries and angling have been stopped in the Loire river, due to the continuing decrease in the catches and the small size of the remaining salmon stock. The reduction in the number of rod and line licences for salmon is continuing.

Iceland: A change in the Icelandic salmon laws enacted in June of 1994 extended the sports fishing season for salmon by 2 weeks, which meant that salmon could be fished in rivers until 30 September. Very few river associations utilized this to extend their fishing season in 1994. The fishing effort in some rivers might have been somewhat reduced due to a lower demand for salmon angling as a result of the economic recession.

Ireland: The numbers of commercial licences sold has decreased steadily over the past 20 years. The maximum number of licences which can be issued for each gear type are: 1,090 drift net, 770 draft net and 410 other commercial (trap, loop, snap and pole) nets. The number of licences taken out in 1994 were 7.2% up on 1993 and was 63% of the total allowable licences.

The number of rod licences issued has increased considerably since 1972, reflecting the continued development of the angling sector. The marked increase in the number of licences sold since 1991 is due to changes in the types of angling licence available, including the introduction of cheaper one-day only licences in 1992. Protection of salmon stocks at sea and inland has developed considerably in recent years and salmon fishing is probably the most regulated fishing activity within the Irish fishing sector. With the increase in naval activity and the acquisition of 14 high speed semi-rigid patrol boats and much improved communications systems, illegal fishing effort is reported to have been significantly reduced.

Norway: There have been no significant changes in gears and effort in marine fisheries. Some new regulations resulted in minor changes in angling effort.

Russia: Along with increased interest in sports fishing there has been a reduction in the effort in commercial fishing in many rivers in the Kola peninsula. In 1994 commercial fishing was stopped in the Ponoy river and catch quotas were set for several rivers. The salmon fishing ban on the Pechora river has continued. In 1994 commercial fishing at river mouth counting fences was conducted in 10 rivers on the Kola peninsula and at 230 upstream fishing stations in one river in the Archangel region. Sea fishing was conducted at 11 coastal stations in the Kola area and 60 stations in the Archangel region. There was no change in the sports fishing effort on the Kola, but catch and release fly fishing by tourists dominated.

Sweden: A total ban on the use of coastal anchored gill nets to catch salmon and sea trout became effective in January 1994 and is still in force.

UK (England and Wales): There have been no significant changes in the methods used in the net fisheries. Effort in the net fishery has continued to decline gradually, largely as a result of the continued phasing out of drift netting in the north-east coast fishery (Table 4.2.1.1). In 1994 the single national rod licence for all species (introduced in 1992) was revised to provide two categories: one for salmon and migratory trout angling (for a substantially higher fee) and the other for non-migratory trout and coarse fish. This has resulted in a reduction in fishing effort and will also permit improvements in catch reporting procedures. In order to reduce levels of exploitation in certain rod fisheries, the use of baits has been prohibited on the River Tamar (SW England); in addition, the season has been reduced in length and anglers may only fish with fly before 15 May on four rivers in the south of England.

UK (N. Ireland): The number of commercial fishing licences issued in 1994 (205) was lower than in 1993 (211), mainly due to a reduction in draft net licences in the Foyle Fisheries Commission area. No changes occurred in fishing seasons or gear regulations.

UK (Scotland): No new fishery regulations have been introduced since the last report, although in a number of net fisheries there have been further voluntary reductions in effort and in some rod fisheries catch and relaese policies have been introduced. There was a small increase in the number of fixed engine gear units used in 1993 compared with 1992 but a slight decrease in the number of net and coble crews operating in 1993 (Table 4.2.1.1).

4.2.2 Catches and catch per unit effort

Catch data are presented in Tables 2.1.1 and 2.1.2. In addition, CPUE data are available for fisheries in the following countries:
Finland: CPUE on the Teno river in 1994 was considerably lower than in 1993 and lower than the mean of the previous four years (Table 4.2.2.1). The reason for decreased catches and CPUE values are unknown.

France: The catch in 1994 was 12% higher than in 1993, slightly higher than the mean of the last five years, but lower than the 10 year average. Estuarine commercial fisheries of the southwest region took 22% of the total catch. Over 70% of the angling catch occurred in the northwest region. Due to the decrease in the number of angling licences the number of salmon caught per rod was by far the highest since 1987.

Iceland: The 1994 sports catch of 105 t was down by ca. 28% compared to 1993 and 23% lower than an average of the previous 20 years. The run started and peaked early, especially in the southwestern area. There was a conspicuous shortage of 1SW salmon in northern Iceland, probably related to a cold spring and poor smolt runs as indicated by smolt traps in 1993. Runs of 1SW salmon in southern and western Iceland were below average. Runs of 2SW salmon were average in the south but fairly strong in northeastern Iceland. Total returns of 308 t to ranching stations were down by 45% from the previous year, partly due to smaller releases in 1993. Overall return rates in ranching were in the 2-3% range, somewhat lower than in 1993.

Ireland: Catches in all regions increased compared to the previous five years. The 1994 declared catch (819 t.) is higher than the five year average but lower than the 10 year average. A substantially improved rod catch estimate was obtained in 1994 which has resulted in a comparatively higher catch being reported compared to previous years. However, this does not account for the full increase in the declared national catch. Drift nets acounted for 72% of the total declared catch, with 18% taken by draft nets, 2% by other nets or traps and 9 % by rod angling.

A reported feature of the season was the exceptionally high catch experienced in the early part of the season (up to the end of June) with few fish landed subsequently. The reason for the sudden decline in catches at sea in the second half of the season is not known but cannot be attributed to weather conditions or reduced fishhing effort.

Norway: As described in the previous Working Group report (Anon. 1994a), from the 1993 fishing season the methods of collecting catch statistics have changed. This change has improved the quality of the statistics, but makes comparisons with earlier years more difficult. In 1993 the total nominal catch was 923 t and the provisional figure for 1994 is 937 t.

Russia: The total catch in 1994 was 138 t, similar to the 1993 catch, but considerably lower than catches in the mid 1980s. This was due to changes in effort and a considerable decline in the salmon stocks in the Barents and White sea areas.

Spain: Significant increases in salmon catches were reported from salmon rivers in Asturias, Spain. There were drastic declines in those rivers in the 1970s, probably related to UDN disease and loss of habitat due to hydropower development. These stocks are now showing signs of recovery, primarily in the 1SW component.

Sweden: The succesive increase in catches that was observed in the years 1990–93 was interrupted in 1994 when the catches decreased by 20% compared to 1993. One possible reason for this decline could be a lowered coastal fishing pressure caused by environmental problems, such as algae and high water temperatures in the sea. On the northern part of the Swedish coast a substantial shift from coastal to river catches occurred. The catches in 1994 were close to the 5 year and 10 year averages.

UK (England and Wales): The estimated total catch for 1994 (319 t) is the highest since 1990 and is close to the 10 year mean (328 t). The estimate for the net fishery in 1994 was 17% better than in 1993 and 24% up on the previous 5 year mean. Rod catches appear to have improved by similar margins although only rough estimates are currently available. Despite these improvements, catches in some rivers in southern England have remained at a very low level. CPUE data are available for the net fisheries in four regions of England and Wales (Table 4.2.2.2). In each area, the levels recorded in 1994 were the highest observed for at least 5 years.

UK (N. Ireland): The provisional declared catch for the 1994 fishery (91 t) was higher than that for 1993 (83 t), but remained below the mean values for the previous 5 and 10 year periods. As in Ireland, very good catches were reported at the start of the summer grilse season, but these fell off dramatically for the rest of the season. In the Foyle system, reported rod catches were very high, with many fish being taken far upstream in some rivers. To a large extent, the phenomenon of substantial very late runs in some rivers, reported in 1993, was repeated in 1994. In UK (N. Ireland) reliable rod CPUE data are available only for the lower R. Bush (Table 4.2.2.1). Overall CPUE in these stretches was down in 1994 compared to 1993, but on average has been higher since 1990 compared to the 1980's. This pattern may not be representative of Northern Irish rod fisheries in general, due to enhancement of rod catches in the lower river by returning experimentally ranched salmon.

UK (Scotland) : The final reported catch for 1993 was 546.5 t. This figure was 23% down on the average for 1988–1992 and 33% down on the value for 1983–1992.

The catch data for 1994 (596 t) are incomplete but already exceed the 1993 final figure. The final figure is likely to be the best catch recorded since 1989. Catch per unit effort in the fixed engine fishery increased in 1993 compared with 1992 while in the net and coble fishery, CPUE declined (Table 4.2.2.3). No effort data are collected from rod fisheries.

4.2.3 Composition of catches

Data on the age composition of catches are presented in Table 2.2.1

Finland: The proportion of 1SW salmon in the catch in 1994 (55%) was almost at the same level as in 1993 (58%) and below the average for the preceding 10 years (62%). However, the numbers of 1SW fish caught has gradually increased since the early 1980's. In the same period the numbers of MSW salmon caught have remained at about the same level or even shown a slight increase. The increase in numbers of 1SW fish may be partly due to succesful regulatory measures in those tributaries of the Teno River which support these stocks.

France: The proportion of 1SW salmon in the 1994 catch was 55%, a lower proportion than recorded in 1993 (65%) but higher than the average of the last 5 years (46%). This high proportion of grilse in the last two years probably reflects an increase in the exploitation rate of 1SW fish in the northwest as a result of a later closure of the angling season and a greater fishing effort directed towards the 1SW component of the stock. At least 25% of the total catch was from hatchery releases, of which roughly 80% came from one river in Brittany, where smolt releases have given high returns.

Iceland: In the Icelandic sports fishery in 1994 about 63% were 1SW and 37% 2SW. This is a low 1SW proportion, reflecting low to average 1SW runs in all areas and relatively strong 2SW runs in northeastern Iceland.

Ireland: The percentage of 1SW salmon in the national catch has ranged from 96% to 81% (1980 to 1988, mean 92%). As the drift net fishery does not operate fully until the summer, MSW fish, which generally enter rivers in spring, are subject to a much lower rate of exploitation than 1SW fish. Reports from a number of areas have indicated increases in rod catches of MSW fish in 1994. However, a full assessment of the composition of the Irish catch is not available for recent years.

Norway: In 1993 the proportion of 1SW salmon in the catch was 60% and this increased to 67% in 1994. In a number of fisheries and rivers in south Norway there appeared to be relatively large proportions of 1SW fish in 1994, and this is further indicated by relatively high return-rates of 1SW fish tagged as smolts in several rivers in 1993.

Russia: The contribution of 1SW fish in the 1994 catch was about 70%, which corresponds to a long-term mean level, but is considerably higher than in the previous year.

Sweden: The proportion of 1SW fish in the 1994 catch was 63%, almost at the same level as in 1993 (62%). The 1SW fish were bigger than in the last three years, while the MSW fish were smaller than in 1993. The low weight of 1SW fish in 1993 and of MSW in 1994 suggest a low growth rate of the 1992 smolt year class. The mean weight of 1SW fish caught in 1994 (2.73 kg.) was close to the average since 1981 (2.83 kg.).

UK (Scotland): In the 1993 reported catch, 57% were recorded as grilse. Scale analyses of samples from major fisheries in each of the statistical regions in previous years have indicated that the actual 1SW proportion is always much higher than the reported figure as a result of 1SW fish being misreported as MSW salmon. The errors in classification are neither consistent between regions, with misclassification being higher in the northern and western regions of Scotland, nor between years.

4.2.4 Origin of catches

The contribution of wild, farm origin and ranched salmon to national catches in the North-East Atlantic in 1991-94 is shown in Table 4.2.4.1.

Ranched salmon

Ranching is defined as the release of reared smolts into the wild with the intention of attempting to harvest all the returning adults or to use them for broodstock. The only country where significant ranching programmes are underway is **Iceland**, where ranched fish have comprised between 70% and 75% of the catch for the past 3 years. Preliminary information suggests that from 1-5% of all returns of ranched salmon stray into rivers; the highest rates being observed on rivers close to ranching stations. Elsewhere, ranched fish have contributed very little to catches.

Releasing smolts for stock enhancement is a widespread practice. In several areas stocking is conducted to improve rod fisheries and few of the returning fish are expected to spawn; this is similar to ranching. This occurs in Norway (e.g. Drammen River), France (where landings of reared fish in rod fisheries account for about 25% of the national catch) and Sweden. In a number of Irish rivers (where this practice is locally refereed to as 'ranching to the rod') significant numbers of these fish may contribute to spawning.

Farm origin salmon

The farmed fish recorded in catches are those that have escaped from fish farms. Farmed salmon are recorded in catches in all countries which have cage farming industries (Table 4.2.4.1).

Norway: The overall proportion of farmed fish in catches was lower in 1994 than in 1993. In samples from coastal fisheries 34 % on average were estimated to be of farmed origin, whereas in the fjord fisheries the corresponding proportion was 19%. In anglers catches in freshwater 5% of the catch was estimated to be of farmed origin (Tables 4.2.4.2 and 4.2.4.3). In 1994 preliminary figures from the Directorate for Fisheries suggest that between 500,000 and 700,000 farmed salmon escaped from cages, which is less than in 1993.

Ireland: New data were presented to the Working Group on the surveys of the commercial salmon catches in Ireland (Table 4.2.4.4). These indicate that between 1991 and 1994 the proportion of fish farm escapees in catches has varied from 0.15% (1991) to 0.54% (1992), although these results may underestimate the true proportion because escapees may be sold separately to the main catch as low quality fish. The actual numbers of these fish has ranged from 390 to 1182. Overall, the rate of escapees is low but these data may not highlight more local effects or the numbers of these fish entering freshwater. The data should be regarded as underestimates as escapees may be sold as sub-quality fish and sold separately to the main catch.

UK (N. Ireland): Data were provided on the occurrence of salmon farm escapees in N. Irish catches during the summer grilse fishery for 1991–1994 (Table 4.2.4.1). Farmed salmon, identified by external examination during tag recovery programmes accounted for a low proportion of the catch, ranging from 0.26% (1993) to 3.72% (1992). Data from the total trap on the R. Bush (Table 4.2.4.5) provide estimates of the occurrence of farmed salmon entering freshwater in the same fishery area. During the period 1991–1994 between 3 and 54 farmed salmon were recorded each year, accounting for 0.1% to 2.8% of the total salmon run.

UK (Scotland): Sampling programmes in 1993 indicated that about 5% of the reported catch was of hatchery origin, many of these being fairly recent escapees from fish farms. Sampling operations were more restricted in 1994, but indications are that farm escapees may have been at about the same level in catches. A new catch reporting form was introduced in 1994, requiring fishermen to report incidences of farm escapees in their catch. The number of fish reported as farm escapees was considerably lower than would have been expected from the 1994 sampling programme.

Catches from other countries:

In 1994 the Working Group estimated the catches of non-national-origin stocks in national catches in the north-east Atlantic. The estimates were made for catches in 1992, and were based upon tagging recovery data in that year or historic data. The Working Group did not consider that there were sufficient new tagging data to warrant updating the model for 1993 or 1994 catches. They also noted that ACFM had proposed that such preliminary estimates should be expressed as percentages of the national catches originating from different countries (Anon, in prep). The disadvantage with this approach is that information on the relative size of the catch between countries is lost. Dividing the catch in weights provides information both on the origin of fish caught in each country and on where fish from each country are caught.

The Working Group felt that it would be valuable to provide a more detailed assessment of the catch composition using tag data and mean catches for a number of years. This could be updated on a periodic basis. It was therefore recommended that an assessment for catches in the years 1991-1994 should be prepared for the 1996 meeting of the Working Group.

4.2.5 Exploitation rates in homewater fisheries

Exploitation rates for various monitored rivers in homewater fisheries in the North-East Atlantic are shown in Table 4.2.5.1.

Iceland: Estimated exploitation rates in R. Elliðaár in 1994 were close to 50%, which is just above average for the last 10 years. This should be fairly representative for other Icelandic rivers.

Ireland: The exploitation rate on the Burrishoole hatchery reared fish was 76% in 1994 which was the highest since 1989.

Norway: Marine exploitation rates of both 1 and 2SW fish on the River Drammen stock were 41% and 33% respectively. The rod exploitation rate in the river was 42% downstream of the salmon ladder and 38% upstream. The marine exploitation of wild and hatchery fish from the River Imsa were about the same as in 1993, and was higher for hatchery fish than wild. There is some evidence to suggest an increase in exploitation rate on this stock in recent years.

Russia: Exploitation rates of salmon in the Barents and White sea basin have been reduced from 35% and 50% in 1990 down to 15% and 30% respectively.

Sweden: The previously assumed 50% exploitation rate in the brood stock fishery in the River Lagan was checked in a pilot tagging experiment in 1994. The data obtained indicate that in 1994 the exploitation rate in this fishery was 30%. No recalculation of previous data will be made until further experiments have been conducted. In the estimates of exploitation rates for 1994, the new figure was used. Since the Swedish tagging experiments will continue, there will be information available on the exploitation rate in the brood stock fishery in coming years.

UK (England and Wales): Exploitation rates in three rivers for which data are available were within the ranges previously observed, although in two (Itchen (50%) and Dee (17%)) they were the highest recorded for at least four years.

UK (N. Ireland): Exploitation of 2SW fish (mainly hatchery origin) from the R. Bush was close to the average for the time series, while exploitation on 1SW hatchery origin fish (of two smolt ages) was a little below average for this stock. No estimate of exploitation of wild grilse is available for 1994, due to low tag numbers.

UK (Scotland): No recent data are available on exploitation rates for fisheries in Scotland other than those calculated for the net and coble fishery in the North Esk. The exploitation rates on 1SW and MSW salmon in this fishery have declined in recent years as a result of effort reductions, reaching a level of 19% for both age groups of salmon in 1994.

4.2.6 Summary of homewater fisheries in the North-East Atlantic Commission Area

In general, there has been a continuation in the trend to reduce commercial fishing effort in the North-East Atlantic area, probably reflecting conservation measures in the respective countries as well as the reduced value of commercially caught salmon. Reductions in commercial fishing effort were reported for salmon fisheries in France, Ireland, Russia, Sweden, UK (England and Wales) and UK (N. Ireland). Only minor changes were reported for Finland, Norway and UK (Scotland), but there was an extension of the sport fishing period in Iceland following a revision of the salmon fishing Act.

Catches in 1994 were reported to be close to or better than the mean of the last five years in France, Ireland, UK (England and Wales), UK(N. Ireland) and UK(Scotland). Norway and Russia reported catches similar to the previous year, but Iceland, Finland (Teno R.) and Sweden had considerably lower catches than in 1993. Catch per unit effort in general followed the same pattern. In Ireland and parts of UK, catches of 1SW were very good at the beginning of the season but declined suddenly before the end of the season.

There seemed to be an increase in 1SW salmon abundance in catches in Ireland, Norway and Russia compared to the previous year. Finland (Teno R.) and Sweden reported similar grilse ratios but France and, in particular, Iceland reported considerable reductions in grilse abundance. No significant trends were reported for MSW salmon.

Ranched fish continue to comprise the majority of the Icelandic catch and some straying is observed into rivers. Fish farm escapees are observed at variable levels in coastal and in-river fisheries in Scotland and in low proportions in catches in Ireland and in catches and rivers in UK (N.Ireland). There has been a reduction in the frequency of escapees in Norwegian coastal waters and rivers mainly as a result of improved cage design, better farm management practices and increased enforcement of regulations.

Considerable reductions of exploitation rates in commercial nets were reported for Russia but exploitation rates in other countries seemed to be similar to previous years, especially in sport fisheries.

4.3 Status of Stocks in the North-East Atlantic Commission Area

4.3.1 Attainment of spawning targets

Provisional spawning targets have been defined for several rivers in the North-East Atlantic Commission area. They are largely derived from stock-recruitment data collected on monitored rivers as presented in Section 8.1.2. Where possible, targets have been set according to guidelines presented in Section 8.1.1. Table 4.3.1.1 shows the targets set for 6 north-east Atlantic rivers and gives time series to assess historical attainment.

In the R Burrishoole (Ireland) the egg deposition target has been met in only two of the past 14 years (14%); however, egg deposition has exceeded 75% of the target in 11 years (78%). It is also noted that the target relates to areas of salmonid habitat contributing to production in recent years and does not reflect historical production levels for this river.

For the R Bush (UK, N. Ireland), target egg deposition has been exceeded in 8 of the last 10 years (80%), and in only one year has egg deposition been substantially below target. It is noted that for several of the years when egg deposition was above target, smolt production was reduced relative to that expected at target level (Kennedy & Crozier, 1993). This is explained by the nature of the stock/recruitment relationship (Section 8.1.1) and serves to illustrate that exceeding the target by a large margin may not yield maximum recruitment. Historical data on target attainment in rivers where such relationships apply should be interpreted with this in mind.

For the N Esk (UK, Scotland) the target was set on the basis of ACFM's definition of MBAL. It has been met or exceeded in all of the time series (1981-93) presented to the Working Group.

For the R Dee (UK, England & Wales) egg deposition was close to the target in one of the past three years and about 50% of the target in the other two years. The shortfall in MSW spawners was greater than for 1SW spawners.

Only a single year's data are available for the R Scorff (France) and these indicate 66% attainment of target egg deposition. In Russia, the R. Tulome has been below target throughout the 12 year period examined and less than 50% for 8 of these years.

For the two longest series provided to the group (Bush R. (UK(N. Ireland)) and North Esk (UK(Scotland)) no common trend was detected over time in the ratio egg deposition/target (route regression, $p>0.1$). It should be stressed that no information is available for the great majority of the north-east Atlantic salmon stock complex. It should also be noted that targets are provided here simply for the purpose of assessing the status of stocks.

4.3.2 Measures of abundance

Catches

Catch figures (Table 2.1.1) do not always provide a good measure of abundance, as various regulatory measures have reduced catches in some countries (e.g. Norway) while in Iceland catches include ranched fish. The presence of fish farm escapees in some areas (e.g. Norway and Scotland) may be significant and so catch statistics may overestimate the abundance of wild stocks. Nominal catches may be affected by variations in effort, fishing conditions and variable run timing in some areas and also by variable rates of unreporting of catches. Therefore nominal catches are not used to measure stock abundance or status in the North-East Atlantic.

Freshwater production

Counts or estimates of wild smolt production, or juvenile survey data are available for 18 rivers (Table 4.3.2.1), and full smolt counts are available for 8 of these. In 1994, low runs were recorded in the Imsa (Norway), Girnock Burn (UK Scotland) and four tributaries of the River Teno in Finland (Ylapulmankijoki, Tsarjoki ,Karigasjoki and Kuoppilasjoki). However, in the case of the River Imsa this is because very few spawners have been released upstream into the river in order to prevent the spread of furunculosis. Counts in the Burrishoole (Ireland) and Bush (UK N Ireland) increased slightly. The majority of counts or estimates were below the mean values for the time series provided. A similar situation was recorded in 1993 and no improvement in smolt production has been generally noted. In northern Iceland the 1993 and 1994 smolt runs were greatly reduced due to cold and unfavourable freshwater conditions in the spring. The estimated smolt run from the Ellidaar River in 1994 was the lowest recorded during 7 years of observation. Similar conditions occurred in the spring of 1994 in the Vesturdalsa River, and smolt counts could not be estimated due to low numbers in these years.

Despite the low level of smolt production, there is no evidence that freshwater productivity in the North-East Atlantic in general has decreased over the past decade, or even within the last 6 years. Route regression analyses were carried out on smolt data for 7 rivers (Oir (France), Orkla and Imsa (Norway), N.Esk and Girnock Burn (UK Scotland), Bush (UK N Ireland) and the Burrishoole (Ireland)) for the past 11 years and on 12 rivers (the rivers listed above plus the Ellidaar and Vesturdalsa (Iceland), Hogvadsan (Sweden) and the Tsarjoki and Ylapulmankijoki (Finland)) for the past 6 years; these showed no common significant trend in juvenile production ($p>0.1$, Table 4.3.2.2).

4.3.3 Escapement

Adult counts or estimates of wild salmon runs in 1994 are available for 21 rivers in the North-East Atlantic area (Table 4.3.3.1).

Counts for Russian rivers were generally higher than the average values for the time series. Counts for rivers in Ireland and UK(N. Ireland) were close to or higher than the average values recorded. No apparent trend was noted for other UK rivers although the count recorded for the Usk was the highest in the 7 year series.

As previously, due to differences in the size of stocks considered and in their migration patterns, route regression analyses were conducted separately on the adult counts in Russian rivers and the counts for the rivers in other countries. An increasing trend was apparent for Russian rivers over the 30 year time series of data ($P < 0.1$, Table 4.3.2.2). However, no trends were noted when the analyses were carried out over the most recent 21, 11 and 6 years. An increasing trend in adult runs to rivers in Scandinavia and western Europe was shown for the previous decade ($P = 0.01$) and for the last 6 years ($P = 0.02$). This probably reflects decreases in the level of exploitation in many areas. This would suggest that the adult runs to freshwater are increasing or at least remaining stable, depending on area.

4.3.4 Survival indices

Estimates of marine survival for wild smolts from 5 stocks returning to homewaters (i.e. before homewater exploitation) and for 7 stocks returning to freshwater in 1994 are presented in Tables 4.3.4.1 and 4.3.4.2 respectively. In Table 4.3.4.2, indices of return rates are also provided from autumn 0+ parr from the Nivelle (France); this provides an approximation of marine survival as more than 80% of the juveniles emigrate after only 1 year in freshwater. Marine survival for the Oir (France) must be regarded as a minimum estimate because it is only a spawning tributary.

Marine survival rates for hatchery smolts are given in Tables 4.3.4.3 (survival to homewaters for 5 stocks) and Table 4.3.4.4 (survival to freshwater for 6 stocks.) New information is provided for the Lagan (Sweden) and Shannon (Ireland). The Working Group noted that estimates of return to homewaters are likely to present a clearer picture of marine survival than returns to freshwater because of variation in exploitation in coastal fisheries.

Route regression analyses of trends in survival of wild 1SW and 2SW fish back to homewaters revealed an overall significant downward trend over the last 11 years based on rivers from UK(N Ireland), UK(Scotland), Norway and Iceland (P = 0.03 and 0.03 respectively). No trend was noted in the most recent 6 years. (Table 4.3.2.2). This pattern reflects a higher level of sea survival in the first half of the last decade compared to the second half. In contrast, survival to freshwater showed a significant increasing trend for 1SW salmon over both periods based on a similar grouping of rivers (P = 0.012 for 11 year period and 0.01 for the 6 year period). This suggests that reductions in exploitation rates in homewaters have compensated for the decrease in sea survival over the last decade.

Results for western European hatchery smolt releases showed similar patterns of change (Table 4.3.2.2). As with the survival of wild fish to homewaters, a significant downward trend in survival was noted for the 11 year period for 1SW returns (P = 0.01) and 2SW returns (P = 0.1). However, few data are available for 2SW survival rates as many hatchery stocks produce predominantly 1SW fish and most of the monitored rivers in the Western Atlantic have 1SW salmon stocks. The 2SW results should, therefore, be viewed with caution. This trend was not evident in the more recent 6 year time period. No trends were noted for the 1SW or 2SW survival to freshwater over the two time periods examined.

4.3.5 Summary of Status of Stocks in the North-East Atlantic Commission Area

Examination of general trends from the analyses carried out in the previous sections suggests that there has been no significant change in smolt production in the North-East Atlantic as a whole. Adult runs in western European rivers appear to be increasing or at least remaining stable probably due to lower exploitation in recent years.

A general downward trend in marine survival was noted for wild and hatchery, 1SW and 2SW stocks over the past 11 years, but this trend is not evident in the most recent 6 years. This suggests that exploitation and marine survival are relatively stable at present. In contrast, survival to freshwater for 1SW wild fish tended to increase over both time periods, which would suggest that reductions in homewater exploitation in recent years has resulted in improved survival to the rivers, despite poor marine survival in this period.

Provisional spawning targets were provided for 6 rivers in the NEAC area. Of the four rivers for which 10 year time series of target attainment data were provided, two had achieved their egg deposition targets in at least 80% of years and two had failed to meet their targets in at least 80% of years. The other two rivers had failed to exceed egg deposition targets in the recent years (one and three) for which data were provided.

4.4 Data Deficiencies and Research Needs for the North-East Atlantic Commission Area.

1. The Working Group supports the continuation of the research fishing programme in the Faroes area and recognises that the results from the project will improve the possibility of developing reliable assessment models in the North-East Atlantic.
2. Historical scale data from the Faroes fishery should be analysed to assess geographical and temporal variation in smolt age composition of wild salmon which may reflect differences in the stock composition of catches. The results should be compared with historical data on tag recoveries in the Faroese fishery area, to determine whether stock composition estimates by both approaches concur.
3. The composition by country of origin of national salmon catches in the NEAC area should be determined from best available data for the fours years 1991-94 combined, as a basis for future comparison.
4. Work should be carried out to refine the estimates of pre-fishery abundance for the North-East Atlantic stocks and to analyse the variability of the

estimates. Where possible, separate data sets should be provided for different parts of each country and fishing effort data should be examined to improve estimates of changes in exploitation rates.

5. Preliminary spawning targets should be established for all rivers in the NEAC area as soon as possible. (It is recognised that this may take at least five years in some countries.

5. FISHERIES AND STOCKS IN THE NORTH AMERICAN COMMISSION AREA

5.1 Description of Fisheries

Canada

The 23 areas for which the Department of Fisheries and Oceans manages the salmon fisheries directly are called Salmon Fishing Areas (SFA) (Figure 5.1.1). For the province of Québec, the management is delegated to the Ministère de l'Environnement et de la Faune (MEF) and the fishing areas are designated as Q1 through Q11. Harvests (fish which are killed) and catches (includes fish caught and released in recreational fisheries) are categorised in two size groups: small and large. Small salmon in the recreational fisheries refer to salmon less than 63 cm fork length whereas in commercial fisheries they refer to salmon less than approximately 2.7 kg whole weight. Large salmon in recreational fisheries are greater than or equal to 63 cm fork length and in commercial fisheries refer to salmon greater than or equal to about 2.7 kg whole weight.

USA

In the USA, angling for sea run Atlantic salmon is permitted only in the State of Maine. Due to the low salmon abundance in recent years many new management measures have been instituted in order to reduce the harvest in home waters and to increase spawning escapement. The sport fishery was further reduced in 1994 by enactment of a new management measure reducing the season bag limit to one salmon less than 64 cm per angler per year. The restrictive management measures put into force in recent years, coupled with extremely low salmon abundance, resulted in a 31% decrease in license sales compared to the previous year (from 2,656 to 1,821). Due to the continued low abundance of salmon in Maine, consideration is being given to prohibiting the retention of any salmon in 1995.

France (Islands of St. Pierre and Miquelon)

On the two islands in 1994, there were 10 (9 in 1993) professional fishermen using an estimated 9180 m of surface gill-net and 26 (28 in 1993)licensed recreational gill-net fishermen using an estimated 13860 m of surface gill-net.

5.1.1 Gear and effort

Canada

Three user groups exploited Atlantic salmon in Canada in 1994: First Peoples fisheries (Indigenous peoples), commercial fisheries, and recreational fisheries. The following management measures were in effect in 1994.
First Peoples fisheries: In Quebec (Q1 to Q11), First Peoples' food fisheries took place subject to agreements or through permits issued to the bands. The permits generally describe gear and fishing effort limits but not catch limits. In SFAs 1 to 23, food fishery harvest agreements were signed with several First Peoples in 1994. The signed agreements included allocations of small and large salmon. Harvests which occurred both within and outside agreements were reported by the Native Bands. The Conne River (SFA 11) food fishery did not occur in 1994 because the expected returns were below the spawning target for the river. Harvest by First Peoples with recreational or commercial licenses is reported under the recreational and commercial harvest categories.

Commercial fisheries: The five-year moratorium which was placed on the commercial fishery in insular Newfoundland in 1992 continued. In Labrador, commercial fishing quotas and numbers of fishers were decreased. Quotas were assigned by SFA. The commercial fishery opened on June 5 and closed on October 15 or when the quota was caught. Commercial fisheries in Quebec were also reduced in 1994 from 1993; these fisheries were active in only two zones, Q9 (July 1 to August 31) and Ungava Bay (Q11) (no close season).

	1989	1990	1991	1992	1993	1994
Labrador						
No. of licenses	610	570	570	495	288	216
Quota (t)	N/A	340	295	273	178	92
Quebec (Q7 to Q9)						
No. of licenses	185	165	152	147	94	90
Quota (number)	33,125	29,605	28,359	23,400	15,325	15,175

Recreational fisheries: Except in Quebec and Labrador, only small salmon could be retained in the recreational fisheries. The seasonal bag limits in the recreational fishery remained at eight small salmon in New Brunswick (SFA 15, 16, 23) and Nova Scotia (SFA 18 to 22) with a daily limit of two retained. In SFA 17 (PEI), the season and daily bag limits were 7 and 1 respectively. In Newfoundland and Labrador, the recreational fishery quotas by SFA which were in effect during 1992 and 1993 were removed in 1994. For insular Newfoundland (SFAs 3 to 14A), the seasonal bag limit in 1994 was reduced from eight in 1993 to six fish, three small salmon prior to July 31 and three small salmon after that date. After the bag limit was reached in each time period, only hook-and-release fishing was permitted. In Labrador (SFA 1, 2 & 14B), there was no seasonal division of the bag limit but the limit for large salmon was reduced from four in 1993 to two, with a daily limit of one fish. In Quebec, season and bag limits varied by zone with seasonal limits of seven to ten fish of any size. Just over 73,000 Atlantic salmon recreational licenses were issued in 1994 throughout Atlantic Canada which represented a potential harvest of approximately 494,000 fish, of which 75% would be small salmon. Rivers in several SFAs were closed to angling for part or the entire season as a result of low stock abundance or low water and high water temperatures. The individual river closures and changes in the management of the recreational fishery have compromised the usefulness of recreational catch data to infer abundance.

5.1.2 Catches and catch per unit effort

Canada

The provisional harvest of salmon in 1994 by all users was 351 t representing about 77,000 small salmon and 42,000 large salmon (Figure 5.1.2.1). The dramatic decline in harvest since 1988 is mostly the result of the large reductions in commercial fisheries effort and, since 1992, the closure of the insular Newfoundland commercial fishery.

The harvest of small and large salmon was divided among the three user groups in different proportions depending on the province and the size group exploited (Table 5.1.2.1). Newfoundland reported the largest proportion of the total harvest of small salmon and Quebec reported the greatest share of the large salmon harvest. Recreational fisheries exploited the greatest number of small salmon in all the provinces.

The text table below shows the First Peoples catches (by weight) and the proportion of the catch which was large salmon in the years 1989-94. The catches in 1994 were 93% of the previous year's catch but were 18% above the previous 5-year average. The proportion of large salmon in the 1994 catches (83%) was similar to that for the years 1989-92:

	Year					
Harvests	1989	1990	1991	1992	1993	1994
Weight (t)	30.4	31.9	29.1	34.2	42.6	39.7
% Large by weight	85%	78%	87%	83%	91%	83%

The commercial harvest in 1994 declined to less than 150 t from more than 2,000 t in 1980 (Figure 5.1.2.2; Table 5.1.2.2). A large part of the declines in harvests is the result of quotas and effort reductions. The quotas and harvests in Labrador and Quebec for the years 1989-94 are shown in the text table below. In 1994, the Labrador commercial quota was exceeded slightly in SFA 2 but was not attained in SFAs 1 and 14B. In Quebec, the quota was not achieved, as in the previous five years.

	1989	1990	1991	1992	1993	1994
Labrador (SFA 1,2 & 14B)						
Quota (t)	N/A	340	295	273	178	92
Harvest (t)	330	202	120	204	112	92
Quebec (Q7 to Q9)						
Quota (number)	33,125	29,605	28,359	23,400	15,325	15,171
Harvest (number)	20,790	19,517	19,653	19,700	14,869	14,240

Commercial catches at Nain, northern Labrador, have been directly associated with landings for the remainder of Labrador. Trends in a catch rate index for two combinations of sub-areas at Nain are shown in Figure 5.1.2.3. Catch rate trends in recent years must be viewed with caution because of decreasing fishing effort directed towards salmon. Catch rate in 1994 improved over 1992 and 1993 in the Dog Island - Black Island area but remained below the long-term average; catch rate for the Kiglapaits - Cutthroat area was the lowest recorded.

Harvest in recreational fisheries has varied, but without a trend, at about 80,000 fish of which small salmon make up on average 85% of the catch since 1984 (Figure 5.1.2.2; Table 5.1.2.3). Recreational catches in 1994 by fishing area were variable and generally less than the catches reported in most of the previous ten years (Figure 5.1.2.4). Small salmon catches were generally above the previous ten-year average catches in Labrador, the north-east coast of Newfoundland and Quebec but were below in all other areas including the Gulf of St. Lawrence, with exception of the Restigouche River (SFA 15). The SFA 3 small salmon catch was the highest since 1984. Large salmon catches were above previous ten-year catches in Labrador, Quebec (Q1 to Q3) and western Newfoundland (SFA 12 to 14) but were among the lowest recorded in all the other areas of eastern Canada.

USA

The restrictive management measures in effect in 1994 resulted in 95% of the sport catch in Maine being released. The documented harvest was 13 salmon and a minimum of 249 additional salmon caught and released. The harvest (number killed) in 1994 was the lowest recorded since angling records have been kept in Maine (mid-1880's). There was no catch per unit of effort information available for Maine in 1994.

The age composition of the 13 salmon harvested in 1994 was one 2SW salmon (illegally retained) and twelve 1SW salmon, of which two were fish farm escapees. Most (70%) of the salmon caught and released were taken in the Penobscot River and were of Maine-origin, although 12% (30) of the fish caught and released (all occurring in the Dennys River) were presumed to have originated from Canadian aquaculture operations. The origin of these fish was determined by their physical characteristics (length, weight, fin condition, non-maturity), scale samples, run timing, and documented observations of similar fish in several other Maine and New Brunswick rivers during the same time period (September - October).

France (Islands of St. Pierre and Miquelon)

The catch of salmon by professional fishermen for the islands of St. Pierre and Miquelon was 2.7 t (Table 2.1.1). Most (approx. 75%) of this catch occurred in June. On St. Pierre, the catch was 2611 kg and on Miquelon, 65 kg. The catch by licensed recreational gill-net fishermen was not declared but was estimated at between 1000 and 2000 kg.

5.1.3 Origin and composition of catches

In the past, salmon from both Canada and USA have been taken in the commercial fisheries of Labrador. No tags of USA origin were reported from this fishery in 1994.

Salmon of Canadian origin in fisheries and returns to rivers were predominantly wild, although in some areas reared fish also occurred. These were either fish released for public enhancement programs or fish which had escaped from private aquaculture operations, usually from net pens (Figure 5.1.3.1).

Commercial aquaculture of Atlantic salmon first occurred in 1980 in the Bay of Fundy with a reported production of 11 t. Production increased exponentially during 1984 to 1992 when more than 10,000 t of annual production was reported. In 1993 and 1994, production was 11,000 and 12,500 t respectively, with operations in the Bay of Fundy accounting for over 90% of the Atlantic Canadian production (Table 3.1.1).

Escapes of Atlantic salmon in the Bay of Fundy area occurred in 1994, most notably in an early September storm, when an estimated 20,000 to 40,000 salmon may have escaped from cages or about the same as estimated for 1993. However, escapees in 1994, perhaps coupled with those from the nearby Eastport area of Maine, USA were significantly more abundant at nearby river counting facilities than in 1993.

Estimated return composition information (and the % determined to be of aquaculture origin) is available for 2 Canadian rivers in this area in 1994, the St. Croix (54%) and the Magaguadavic (90%). Aquaculture escapees were also reported, although in small numbers, from the Saint John (SFA 23), Bras d'Or Lake rivers (SFA 19) and Conne River (SFA 11).

Aquaculture escapees were documented in four Maine rivers in 1994. In addition to the St. Croix referred to above, escapees were observed in the Dennys River (42 of 47 in trap catch, 32 of 33 in rod catch), the Pennamaquan River (numerous adults and juveniles in lower portions of the system) which is not stocked, and the Narraguagus River (1 of 52 in trap catch).

The proportion of aquaculture origin salmon in catches on the Magaguadavic River from 1992-94 is shown in the table below (information for earlier return years is included for comparison). The proportion in 1994 was the highest for the three years for which the information has been recorded

Year	1SW	Prop.1 SW from Aqua'	MSW	Prop. MSW from Aqua '	Total	Prop. total from Aqua'
1983	303	-	637	-	940	-
1984	249	-	534	-	783	-
1985	169	-	466	-	635	-
1988	291	-	398	-	689	-
1992	238	0.35	201	0.31	439	0.33
1993	208	0.46	177	0.29	385	0.38
1994	1064	0.94	228	0.73	1292	0.90

Other species cultured commercially in eastern Canada include Arctic charr and rainbow (steelhead) trout. The Arctic charr production occurs in Newfoundland, all in shore-based facilities. Rainbow trout are cultured in the Bay of Fundy, Bras d'Or Lakes (SFA 19) and in Bay d'Espoir (SFA 11). In 1994, production of rainbow trout was 400 t from the Bay of Fundy, 300 t from the Bras d'Or Lakes and over 300 t from Bay d'Espoir. Escapees of both Arctic charr and rainbow trout have been recorded in many rivers in proximity to these production facilities.

5.1.4 Historical data on tag returns and harvest estimates

The Working Group updated the Carlin tag return harvest assessment for 1SW salmon intercepted in the Newfoundland-Labrador commercial fishery (Anon. 1994a). Tag return and harvest summaries for 1SW and 2SW salmon intercepted in Atlantic Canada and for 2SW salmon intercepted in Newfoundland and Labrador are not updated since there have been no new tag returns.

Table 5.1.4.1 consists of a summary of salmon returns to Maine in 1994 used as input values to calculate the homewater RATIO parameter used in the harvest model. There have been no changes in the historical data. The sport fishery landings remain low due to low abundance of salmon in Maine rivers and due to the effect of the new bag limits in the Maine fishery. This further complicates the interpretation of the run estimates derived for the harvest model because run sizes on rivers without traps are underestimated.

Estimates of tags (2SW salmon), run sizes in Maine (2SW salmon), and RATIO parameters are presented in Table 5.1.4.2 (see Anon. 1987 and Anon. 1989). Trapping facilities on Maine rivers are assumed to be 85% efficient, thus returns to these rivers are corrected for this factor. For 1994, the estimates of tags and run size to Maine rivers are 8 and 958, respectively (Table 5.1.4.2). The run estimate suggests the returns to Maine rivers are at their lowest point since the late 1960's when restoration efforts began. The RATIO parameter for the 1994 run was 0.0086. This continues a trend of low RATIO values that began in 1990 and reflects the decrease in releases of Carlin tagged fish from approximately 100k in 1989 to 50k in 1993. In fact, this is the lowest RATIO value for the time series, suggesting the survival of this tag group was very low. As a consequence, the factors used to raise tags recovered in distant water fisheries to harvests are large and may be imprecisely estimated.

Summaries of tag returns by year in Newfoundland and Labrador can be found in Table 5.1.4.3. Only one tag, returned from SFA 2, was reported from the 1993 fishery. Harvest estimate totals are unchanged for the historical time series (Table 5.1.4.4). The 1993 harvest estimate of 129 salmon is lower than the 1992 estimate and among the lowest in the time series. The harvest estimate is based on all tag returns, and as such includes removals by gears other than commercial gill nets.

The ratio of grilse to 2SW salmon returning from the 1992 cohort was 0.498 which is among the highest values in the time series (Table 5.1.4.5). The ratio of the harvest to the 2SW run was reduced sharply in 1992 (data from the 1992 fishery and 1993 run), and in part reflects the effect of the fishery moratorium around insular Newfoundland (Table 5.1.4.5). This trend is continued with the data point for 1993.

5.1.5 Exploitation rates in Canadian and USA fisheries

Recreational fisheries:

Exploitation rates are estimated in a limited number of rivers where the recreational landings and the returns to the rivers are known. This information is summarised in Table 5.1.5.1.
Recreational fisheries were closed in 50 rivers, mainly because of the low abundance of the stocks.

Exploitation of large salmon is not permitted, except in most rivers of Québec and in all rivers of Labrador. Where calculated on those rivers, 43% of the rivers had an exploitation rate over 30%, 51% within a range of 10-30%, and 5 % below 10%. In all the other SFAs and in USA, only small salmon could be retained. Where calculated on those rivers, exploitation rates for small salmon exceeded 30% in 38% of the rivers, was within the range of 10-30% in 28% of the rivers and was below 10% in 34% of the cases.

Exploitation rates for 1SW salmon in Maine (USA) rivers was less than 1% in 1994 due to the restrictive management measures and low salmon abundance. For the first time in Maine history, the harvest of MSW salmon was not permitted.

Commercial fisheries:

Extant and fishery-area exploitation rates for Maine-origin salmon stocks taken in Canadian and Greenland fisheries were updated by the Working Group. Updated time series of run size by sea-age and fishery harvests are given in Table 5.1.5.2. The assessment is based on the results of tagging experiments with external Carlin tags. The models used to calculate harvest and exploitation contain a number of assumed parameters known to affect the precision of the results. Reporting rate is believed to be an important source of variability in the exploitation models (Anon. 1994a).

In past assessments, Carlin-based harvest estimates were presented using the assumed tag reporting rates (Carlin adjustment = 1) or by doubling the numbers of tag recoveries (Carlin adjustment = 2), which assumes that reporting rates were actually half the assumed levels. The Working Group believes neither approach gives an accurate depiction of the time series of reporting rate. The Working Group considered it important to use the best available information on reporting rate to estimate trends in exploitation of Maine-origin stocks. Thus for this assessment, a time series of varying Carlin tag reporting rate adjustments (VAR CA) (Table 5.1.5.2) has been introduced, based on the assessment presented in Anon (1993a). That assessment suggested reporting rates changed during the period 1987-1989 from levels that appeared to be half of the assumed rate based on comparisons with coded wire tag data.

Extant exploitation rates: A model to calculate extant exploitation rates of 1SW and 2SW Maine origin salmon was presented in Anon (1990a). In previous years, alternative values of natural mortality and the fraction of the stock not available to the fisheries were used. However, the fraction unavailable is not relevant to the estimation of extant exploitation rate and natural mortality has only a very small effect on the assessment (Anon. 1994); these factors have therefore been ignored in this analysis. However, tag reporting rate is still considered by the Working Group to have a significant effect. The effects of different levels of reporting rate were evaluated by computing exploitation under three regimes: baseline rate (1X), reporting rate increased by a factor of 2 (2X), and variable reporting rate (VAR). The extant exploitation rate for 1SW Maine origin salmon in 1993 was 30% by the 1X and VAR model despite widespread closures of fisheries affecting US stocks (Table 5.1.5.3). The extant exploitation rate for 2SW has been 0% in the last two years of the time series since no tags have been recovered in distant water fisheries.

Fishery Area Exploitation Rates: Fisheries for non-maturing 1SW salmon of North American origin occur simultaneously in West Greenland and Canada. Estimates of exploitation rates in these fisheries depend on what proportion of the extant stock is thought to be vulnerable to each fishery. Estimates of exploitation rates are presented in Table 5.1.5.4; these are based on the assumption that the population of 1SW Maine origin salmon is available to only the Newfoundland and West Greenland fisheries (i.e. Fraction Unaccounted, FU=0.). A monthly natural mortality rate of 0.01 was used in all cases. However, unlike previous assessments, only the time series of variable Carlin adjustment were applied to the harvest values. Levels of P (the proportion of the stock migrating from Canada) of 0.1, 0.5 and 0.9 were evaluated.

The values for 1993 show that exploitation rates in both Canada and Greenland, based on 1 and 2 tags reported from these countries respectively, were among the lowest estimated for the time series. Using model output for P=0.5, exploitation in Canada was 20% compared to the Canadian time series average of 50%, and 38% in Greenland compared to the Greenland time series average of 59%.

5.1.6 Summary of North American Fisheries

Canada

Gear and effort: The moratorium on the commercial fishery in Newfoundland continued in 1994. Quotas were reduced in the remaining commercial fisheries in Labrador and Quebec. Seasonal bag limits in the recreational fishery in both Newfoundland and Labrador were reduced and the seasonal bag limit within Newfoundland was further subdivided into two seasons, before and after July 31. Rivers in several fishing areas were closed to angling for part or the entire season as a result of low stock abundance or low water and high water temperatures. There were no changes in gear used in Canada.

Catch: The total salmon landings for Canada in 1994 were 351t, which was the lowest recorded landing since 1960 (Table 2.1.1). The landings of small and large salmon were 41 % and 54 % of the previous 5 year averages respectively. The decline in commercial catches from 1593t in 1987 to 141t in 1994 has been influenced by the closure of fisheries in SFAs 3-14A in 1992, a reduction in quotas and the general decline in population size. Harvest in recreational fisheries has varied, but without a trend, at about 80,000 fish of which small salmon make up on average 85% of the catch since 1984. The 1994 recreational catch, however, was the 3rd lowest since 1974 at slightly more than 71,000 fish. Recreational catches in 1994 by fishing area were variable and generally less than catches reported in the previous ten years. Small salmon recreational catches were generally above ten year averages in Labrador, Quebec and north-east Newfoundland and lower in almost all other areas. Large salmon recreational catches were above previous ten year averages in Labrador, Quebec (Q1-Q3) and western Newfoundland (SFA 12-14) but were among the lowest recorded in all the other areas of eastern Canada.

Composition and origin of catch: There were no salmon of USA origin detected in Canadian catches in 1994. Fish farm escapees were detected primarily in rivers in the Bay of Fundy (SFA23) where the majority of the aquaculture industry is located.

USA

Gear and effort: There were no changes in gear used in 1994. The only fishing directed at Atlantic sea-run salmon is by angling in the State of Maine. This fishery was further reduced in 1994 by restricting the season bag limit to one small (<64 cm) salmon per year per angler. There was a 31% decrease in licence sales (from 2,656 to 1,821) from the previous year.

Catch: The recreational harvest was the lowest recorded at 13 fish; an additional 249 fish were caught and released. Most (70%) of these fish were caught and released in the Penobscot River. Exploitation rates for 1SW salmon in Maine were less than 1%.

France (Islands of St. Pierre and Miquelon)

The catch of salmon for the islands of St. Pierre and Miquelon in 1994 was 2.7t by 26 professional fishermen, an increase of 50% over that reported last year. An additional 1-2 t was harvested by recreational gill-net fishermen. Catches as high as 3 t were reported in 1983-85.

5.2 Status of Stocks in the North American Area

There are approximately 550 Atlantic salmon rivers in eastern Canada and 21 rivers in eastern USA each of which could contain at least one stock. Assessments are prepared for a limited number of specific rivers, mostly on the basis of the size of the Atlantic salmon resource within the river, the demands by user groups, and as a result of requests for biological advice from fisheries management. The status is evaluated in terms of the returns and escapement relative to the conservation target.

5.2.1 Spawning targets

In eastern Canada, conservation for salmon is defined as follows:

"That aspect of renewable resource management which ensures that utilisation is sustainable and which safeguards ecological processes and genetic diversity for the maintenance of the resource concerned. Conservation ensures that the fullest sustainable advantage is derived from the resource base and that facilities are so located and conducted that the resource base is maintained." (CAFSAC Adv. Doc. 91/15).

The operational translation of conservation for eastern Canada and USA is based on an egg deposition rate of 240 eggs.100m^{-2} of fluvial rearing habitat and in addition for insular Newfoundland, 368 eggs.ha^{-1} of lacustrine habitat (for the northern peninsula of Newfoundland (SFA 3 and 14) and for Labrador, 105 eggs.ha^{-1} of lacustrine habitat is used). Targets for rivers are defined in terms of eggs and can be translated into the number of salmon required to meet the target using values of the average biological characteristics of the stock.

In 1993, the Working Group provided estimates of the numbers of large salmon which would be required to satisfy the egg deposition targets which have been adopted in North America (Anon., 1993a). These egg targets are generally derived using habitat information from rivers and also, in the case of insular Newfoundland, lakes. Derivation of the optimal spawning numbers of 2SW salmon continues to be problematic because it requires some estimate of the desired sea-age composition of spawners. In Table 5.2.1.1, the targets first described in Anon. (1993a) are again noted. Spawner targets for SFA 22 have been removed as there is no evidence that they contribute to distant water fisheries and production of salmon from these rivers has not been included in the return estimation procedure described in Section 8.1.2. Changes were also made from last year in target spawner requirements in 2 areas of Québec as a result of reassessment of the available habitat. This resulted in a significant decrease (50%) in the estimate for area Q5 as the estimated amount of habitat in the Jacques Cartier River has been reduced. In 1994, targets for SFAs 18-23 in the composite total were the numbers of large salmon needed for spawning. For this year, the Working Group decided to use the mid-point of the minimum and maximum values provided for targets for 2SW salmon only, thus lowering the target in these areas. Overall, the target for 2SW salmon spawning in Canadian rivers has been decreased (3%) from 162,638 to 157,287.

In the United States, a review of available salmon rearing habitat in freshwater has been completed (see Section 9.2). These changes resulted in a decrease (6%) in the 2SW salmon spawning requirements for the USA from 31,103 to 29,199 (Table 5.2.1.1).

The overall target number of 2SW spawners in North America is now 186,486. This represents a marginal decrease (4%) on the target of 193,741 used in 1994 (Anon., 1994a). Most (84%) of the 2SW North American target spawner escapement is required for rivers in Canada.

The Working Group again recommends that these targets be refined as additional information on sea-age composition of spawners becomes available and as further understanding of life history strategies is gained.

5.2.2 Measures of abundance

Canada

A total of 63 rivers were assessed in eastern Canada in 1994. Estimates of total returns of small and large salmon were obtained using various techniques; 36 were derived from counts at fishways and counting fences, 7 were obtained using mark and recapture experiments, 3 using visual counts and mark/recapture combinations, 12 from visual counts of spawners, and 5 from angling and food fishery catches. Of the 63 stocks for which returns of salmon were determined in 1994, comparable data were collected in 1993 for 54 of these. The comparisons between returns in 1994 and 1993 are summarised in the table below. Large salmon returns in 1994 were higher than in 1993 in 11 out of 19 rivers in the Gulf of St. Lawrence but lower in 4 out of 7 rivers in the Bay of Fundy / Atlantic coast of Nova Scotia and in Newfoundland. Small salmon returns were lower in 1994 in 11 out of the 19 rivers in the Gulf of St. Lawrence and Newfoundland and either up (3) or down (3) in the 7 rivers of the Bay of Fundy / Atlantic coast of Nova Scotia.

	Number of rivers in each category			
		Returns in 1994 relative to returns in 1993		
Size group	Total	<90%	90% to 110%	> 110%
Bay of Fundy, Atlantic coast of NS				
Small + Large	2	1	0	1
Small	7	3	1	3
Large	7	4	0	3
Rivers flowing into the Gulf of St. Lawrence				
Small + Large	16	3	5	8
Small	19	11	3	5
Large	19	7	1	11
South, Northeast Newfoundland and Labrador				
Small	10	8	0	2
Large	9	5	3	1

Fewer rivers, 34 in eastern Canada, have had returns enumerated going back to 1984. For these rivers, the returns in 1994 were generally among the lowest observed in the time series, with a few exceptions (Table 5.2.2.1). Most of the rivers in SFAs 15 to 23 and Q1 to Q10 had returns of both small and large salmon which were ranked sixth or less (a rank of 1 means the returns in 1994 were the highest, a rank of 11 means the returns in 1994 were the lowest during 1984 to 1994). Returns to Newfoundland were improved from the previous ten years; returns to most rivers were among the top four in the last 11 years.

In most rivers returns in 1994 were among the lowest since 1980 (Table 5.2.2.1). Only a few rivers in each area had returns in 1994 which were the highest since 1989.

Estimates of annual returns of salmon, differentiated into small and large size categories have been estimated for 14 rivers since 1984 (Figure 5.2.2.1). These returns do not account for commercial fisheries removals in Newfoundland, Labrador and Greenland. Small salmon returns were higher during 1986 to 1988 when there was a commercial fishery as compared to 1993 and 1994 when the Newfoundland fisheries were closed. The abundance of several stocks of salmon in Newfoundland and Labrador, reconstructed to include catches in commercial fisheries, has declined since 1974.

Total returns of 2SW salmon to coastal areas and rivers were estimated for all of the geographic regions of North America (Labrador, Newfoundland, Gulf of St Lawrence, Scotia-Fundy and USA) using the methods in Rago et al (1993a) (Table 5.2.2.2).

USA

Despite increased stocking of hatchery reared salmon in New England rivers during recent years (Figure 5.2.2.2) the numbers of salmon returning to most USA rivers continued to decline in 1994 (Figure 5.2.2.3). Documented returns of 1SW salmon were 5% lower than the previous year, 44% below the 5-year mean and 50% below the 10-year mean. Returns of MSW salmon were 37% below those documented in 1993, 52% below the 5-year mean and 62% below the 10-year mean.

Returns to the Penobscot River (1,049) in 1994 accounted for 65% of the USA total. Returns of small salmon to the river declined by 12% compared to 1993, while returns of large salmon declined by 43%. Returns of large salmon were 56% and 63% below the previous five and 10-year means, respectively. Salmon returns to most other Maine rivers were the lowest observed since detailed records have been kept by the Maine Atlantic Sea Run Salmon Commission (1948).

Total returns to the Merrimack River in New Hampshire (21 salmon) were 66% lower than the previous year, 63% below the previous 5-year mean, and 88% below the 10-year mean.

Adult returns of 326 salmon to the Connecticut River were the 4th highest since inception of the program and were 65% greater than 1993, 29% greater than the 5-year mean, and 28% greater than the 10-year mean. The increased returns to the Connecticut River may have been due to increased fry stocking in recent years, releases of smolts in the lower portions of the drainage, installation/operation of improved downstream fish passage facilities and decreased marine exploitation.

5.2.3 Escapement

Canada

Egg depositions exceeded or equalled the specific river targets in only 19 of the 63 rivers assessed in 1994 and were less than 50% of target in 19 other rivers (Figure 5.2.3.1). Large deficiencies in egg depositions were noted in the Bay of Fundy and Atlantic coast of Nova Scotia (SFAs 20 to 23) where 8 of the 13 rivers assessed had egg depositions which were less than 50% of target. Six rivers under colonisation received egg depositions which were less than half the target; five of these were in Newfoundland.

Escapement over time relative to targets has improved in some areas of eastern Canada but has declined in others (Tables 5.2.3.1 and 5.2.3.2). The Bay of Fundy/Atlantic coast of Nova Scotia rivers status has declined. Most of the rivers received egg depositions in 1994 which were less than half of the target whereas in previous years, some of these rivers met or exceeded target; the most important example being the Saint John River (SFA 23). In the Gulf of St. Lawrence, the number of rivers which received egg depositions less than 50% of target has increased since 1992. In the major river, the Miramichi (SFA 16), target egg deposition has been exceeded in 8 of the last 10 years. An improvement in egg depositions in Northern Peninsula and east coast rivers in Newfoundland was noted in recent years; during 1989 to 1991, more than 50% of the rivers assessed received less than 50% of the target egg requirements.

For assessment purposes, Salmon Fishing Areas were pooled into the following regions: Labrador (SFA 1-2), Newfoundland (SFA 3-11), Quebec (Q1-Q11), Gulf of St. Lawrence (SFA 12-18), Scotia-Fundy (SFA 19-23) and USA. Returns of 2SW salmon (Table 5.2.2.2) were estimated using the methods in Rago et al (1993a). Estimates for 2SW spawners were derived in Anon. (1993b) and updated at the current meeting (Table 5.2.3.3).

The comparison between spawners, returns and spawning targets for 2SW salmon are shown in Figures 5.2.3.2 and 5.2.3.3.

Returns in Labrador are below target levels. The downward trend in spawners and returns which was evident until 1991 appears to have been reversed and spawner numbers have been increasing since 1992, coinciding with reduced levels of participation in the commercial fishery. However, the estimation method to calculate the return and spawner values is dependent upon assumed levels of exploitation in the commercial fishery.

In Newfoundland, returns are below target levels. Some increase has been noted in the last 3 years coinciding with the closure of the commercial fishery in 1992.

In Quebec, returns have been below target levels in all years except one (1980). Spawner populations have consistently been at about 1/3rd of target over the time series. Salmon at 2SW age are harvested within this area by commercial, recreational and native fisheries.

In the Gulf of St. Lawrence area, there have been many years that returns to rivers have exceeded target spawners and about 6 years that spawners have exceeded or almost met targets.

In the Scotia-Fundy area, returns and spawners have declined steadily since 1985. At this time both returns and spawners were exceeding spawning targets. Harvests have been practically eliminated in this area in 1994 and spawners are less than half of targets.

The overall target for Canada could have been met or exceeded in only 3 of the past 21 years (considering the mid-point of the estimates) (1974, 1977, 1980). In the remaining years, spawning targets could not have been met even if all in-river catches had been eliminated.

Where spawning targets have been met or exceeded in recent years, the juvenile abundance in the rivers has increased. Densities of juveniles have been monitored annually since 1971 in the Miramichi and Restigouche rivers (SFA 15 & 16). In these rivers, juvenile densities of young-of-the-year (fry) and parr (juveniles of one or more years old) have increased since 1985 in response to increased spawning escapement (Figure 5.2.3.5). High densities of juveniles have also been reported from other southern Gulf of St. Lawrence rivers (SFA 18). The abundance of parr in the headwater lakes of the Gander River (SFA 4) increased in 1993 and 1994 apparently in response to increased spawning escapement. This is in contrast to juvenile densities from an inner Bay of Fundy river (Stewiacke River - SFA 22) which have declined since 1984, in part as a result of reduced spawning escapement. Except for the rivers along the eastern and southern shores of Nova Scotia which have been impacted by acid precipitation, the freshwater production of the monitored rivers in Atlantic Canada has increased or remained constant at high levels since 1985. This is in direct response to the increased spawning escapement to the rivers resulting from the closures of the commercial fisheries in SFAs 15 to 23 and the introduction of hook and release regulations on large salmon in the recreational fisheries.

USA

For the USA area, returns and spawners have been far below the targets developed for the rivers now accessible to salmon. Both spawners and returns have declined since 1985.

Total observed counts and estimated spawning escapement for 1994 (including hatchery broodstock) of Atlantic salmon to the Penobscot, Merrimack and Connecticut rivers are shown in Table 5.2.3.4. Spawning escapement for the Penobscot River was 12%

of target compared to 19% the previous year, while the Merrimack and Connecticut escapement were similar to the previous years (1% and 3%, respectively). A comparison of the 2SW returns and 2SW spawners with targets for USA restoration rivers is shown in Figure 5.2.3.2; both returns and spawners have been well below target throughout the period 1974-94.

Escapement variability in North American stock complexes

The projected numbers of potential 2SW spawners that could have returned to North America in the absence of fisheries can be computed from estimates of pre-fishery abundance (see section 9.1.2) taking into consideration the 11 months of natural mortality at 1% per month. These values, along with total North American 2SW returns, spawners and targets are shown in Figure 5.2.3.4 and show that the overall North American spawner target could have been met in all years except 1993 and 1994. The difference between the projected returns and actual 2SW returns reflect the extent to which fisheries at West Greenland and in SFAs 1-14 have reduced the populations. The difference between the actual 2SW returns and the spawner numbers reflects in-river and coastal removals.

In 1994, the Working Group (Anon. 1994a) undertook a preliminary analysis of the effects of escapement on potential fishery yield. It was noted that the stock-recruitment relationship ultimately defines the sustainable level of harvesting and its expected variability over time, although spawning stock size is often not a significant variable in models relating recruitment to stock and environmental variables. The analyses of a reduced sample (12 data points) reinforced the importance of abiotic variables for marine survival while simultaneously illustrating the importance of spawner numbers (Anon. 1994a). The establishment of strong correlations between recruits and an environmental variable is sometimes used to support the notion that spawning stock is unimportant. However, it was concluded that if environmental variability regulates survival in a density-independent fashion, then the importance of stock size is enhanced.

Following on the technique outlined in Anon. (1994a), the spawners in each geographic area were allocated (weighted forward) to the year of the non-maturing 1SW component in the Northwest Atlantic using the weighted smolt age proportions from each area. The total spawners for a given recruitment year in each area is the sum of the lagged spawners. Because the smolt age distributions in North America range from one to six years and the time series of estimated 2SW spawners to North America begins in 1974, the first recruiting year for which the total spawning stock size can be estimated is 1982 (although a value for 1981 was obtained by leaving out the 6-year old smolt contribution which represents 4% of the Labrador stock complex). Since the 1994 2SW spawners to North America are known, the spawning stock contributing to the pre-fishery abundance up to 1997 is known. Estimates of the 2SW lagged spawners to each geographic area in North America are in Table 5.2.3.5.

The relative contribution of the stocks in the geographical areas to the total spawning escapement of 2SW salmon has varied over time. The reduced potential contribution of Labrador and the increasing importance of the spawning stock from the Gulf rivers to future recruitment is most evident (Figure 5.2.3.6).

Spawning escapement to several of the stock complexes has been well below target (Labrador, Scotia, Quebec) and generally decreasing since 1990 (Figure 5.2.3.7). Recruits per spawner for the entire North American stocks has also declined in large part as a result of decreased marine survival (Table 5.2.3.5). Thus abundance of non-maturing 1SW salmon would not be expected to increase dramatically in most areas of North America even if the sea survival improves. Only the Gulf stock complex has received spawning escapement which has been close to target, all other stock complexes are well below target and some have declined even further. For the 1995 to 1997 pre-fishery years, the Gulf stock spawners make up 52% to 63% of the total North American spawning stock while they represent 27% of the total 2SW North American spawning target.

5.2.4 Survival indices

Canada

Counts of wild smolts are available from six rivers in Newfoundland, two rivers from Quebec, and three tributaries of rivers in the Maritime Provinces. These provide direct measurements of the outputs from the freshwater habitat. Smolt output can vary by almost five times from one year to the next but in the counts for entire rivers, smolt output has generally varied in magnitude by about a factor of two (Table 5.2.4.1).

Generally, the number of smolts leaving the rivers depends upon the number of eggs deposited. For that reason, among others, smolt output is not constant from year to year. The production among river systems is also not necessarily synchronised and it is not possible to calculate how many smolts in total leave the rivers of Atlantic Canada in any given year. The four rivers which have estimates of the total smolt output in the last five years indicate that in 1994, the number of smolts leaving the rivers was generally down, compared to 1993 and previous years.

Counts of smolts and adult salmon returns enable estimates of marine survival to be derived. Examination of trends over time provide insight into the impact of changes in management measures or other factors that can influence the production of salmon. Information from 11 rivers in Atlantic Canada with at least four years of smolt counts and corresponding adult counts are available; three are hatchery stocks and 8 are wild populations. Geographically, populations for which data were available ranged from the Saint John River (SFA 23- Bay of Fundy) in the south, Liscomb River (SFA 20) along the Atlantic coast of Nova Scotia, Anse à la Barbe and Saint Jean (Q2) in the Gaspé region, de la Trinité and Aux Rochers (Q7) Quebec north shore, and other populations from southern Newfoundland (SFAs 9 and 11) and the Great Northern Peninsula (Western Arm Brook, SFA 14A) (Figure 5.2.4.1).

In general, survival of hatchery stocks is lower (avg. by river over all years from 0.30 to 1.38%) than that of wild stocks (avg. over all years of 0.43-8.53%). Similarly, survival of hatchery stocks is more variable (C.V. from 67.5-85.5%) than wild stocks (C.V. from 18.0-51.9%).

Survival for many of the populations, both wild or hatchery, shows a declining trend over time, particularly in recent years. Western Arm Brook (SFA 14A) and Northeast Brook (Trepassey) (SFA 9), however, have shown consistent increases over the past two to three years but still remained below or comparable to pre-salmon moratorium years. On Newfoundland rivers, small salmon returns prior to 1992 would have been affected by the commercial fishery. Since then, survivals would have been expected to have increased as a result of the commercial salmon fishery moratorium.

A rank ordering of survival values indicated that:

- 5 of the 11 river, had the lowest survival recorded in the 1993 smolt year-class (adult returns in 1994),
- 8 of 11 rivers had the lowest sea survivals during moratorium years (i.e. adult returns in either 1992, 93, or 94),
- 10 of the 11 rivers had either the lowest or second lowest survivals coinciding with the moratorium years.

Both hatchery and wild populations displayed similar trends and, for the most part, were consistent over wide geographical areas. Given the large scale reductions in marine exploitation that have occurred over the past several years, sea survival of many salmon populations has not increased in the manner expected. Returns to the Bay of Fundy rivers continue to decline or stay low and in these rivers the spawning stock is not replacing itself; the causes of which remain uncertain. A similar situation may be occurring at Conne River and various factors have been examined for their contribution to the declining sea survivals; none were conclusive.

Marine conditions in 1993 would have affected the small salmon returning to the rivers in 1994. Cold spring conditions are likely to have a significant impact on the early sea survival of post-smolts. In the Gulf of St. Lawrence in 1993, the ice duration was longer than normal and for several of these rivers, sea survivals from the 1993 smolts were among the lowest recorded. Off Newfoundland and Labrador, the ice coverage from April to June was generally greater than normal although farther offshore than in recent years. Cold spring conditions were also evident at Conne River (SFA 11) where an air temperature index for the period April 1 to May 15 has shown a consistent decline since 1987. The coldest cumulative temperatures were recorded in 1991 to 1993, which corresponds to the lowest smolt sea survivals (Figure 5.2.4.2). Cold spring temperatures continued at Conne River in 1994. Elsewhere in Newfoundland and Labrador, ice conditions in the early spring of 1994 were above normal but not as severe as in 1993.

USA

The survival of hatchery-reared smolts released in the Penobscot River (USA) to 1SW and 2SW returns to home waters is shown in Figure 5.2.4.3. Both small and large salmon returns continue to exhibit a downward trend, with the 1992 smolt class exhibiting the lowest recorded survival during the time series. The previous lowest survival was for the 1991 smolt class.

Data were presented to the Working Group estimating smolt production and marine survival for a Maine river with a wild salmon stock. Smolt survival to home waters for Narraguagus River smolts leaving the river in 1992 was estimated to be between 0.52% and 1.04%. The only previous estimate of wild smolt survival in Maine (conducted in the mid-1950's) resulted in marine survival estimates ranging from 3%-5%. These data corroborate the documented decline in Penobscot River hatchery smolt survival.

5.2.5 Summary of status of stocks in NAC Area

Returns in 1994 of small and large salmon to rivers of eastern North America were among the lowest observed in the last five years. In the more southern areas, while some returns were also among the lowest in the last eleven years, a minority of rivers had returns in 1994 which were the highest. The closure of the commercial fisheries in SFAs 15-23 and Q1-Q3 in 1984 resulted in a noticeable increase in returns of small and large salmon to the rivers. The effect of this reduced marine exploitation and the reduced in-river mortality as a result of the mandatory hook and release of large salmon in the recreational fishery in many areas of eastern Canada, has been increased egg depositions in many rivers and increased juvenile abundance. In some areas, such as the Bay of Fundy, the increased escapement has not been sustained, returns to these rivers are now lower than they were prior to 1984.

The commercial fishery moratorium in Newfoundland introduced in 1992 and maintained in 1993 and 1994 has had the most noticeable impact on the escapement to rivers of Newfoundland and Labrador. Areas in Newfoundland which showed little or no improvement in escapement to the rivers during the moratorium years (SFAs 11 to 13) have either early run stocks and/or the exploitation on these stocks had already been reduced by the delayed opening of the commercial seasons in 1978 and 1984. Generally, the proportion of large salmon in the returns to the rivers during the moratorium years were higher than in the period 1986 to 1991. While returns of large salmon showed an overall improvement in the last three years, higher returns had been observed at several monitoring facilities in years prior to the moratorium. It was generally felt that had the moratorium not been in effect, severe over-exploitation of many Atlantic salmon stocks would have occurred in 1994.

Despite increased stocking of hatchery reared salmon in USA during recent years, the numbers of salmon returning to most USA rivers continued to decline in 1994. Returns of MSW salmon were 37% below those documented in 1993 and 62% below the ten- year mean. Egg depositions exceeded or equalled the specific river targets in only 19 of 66 rivers assessed in 1994 in Canada and USA. Large deficiencies in egg depositions were noted in the Bay of Fundy, the Atlantic coast of Nova Scotia and throughout the USA. When estimates of 2SW spawners only are considered in comparison to targets for this group, the status of stocks is of greatest concern in the USA, Scotia-Fundy area (SFAs 19-23) and Labrador (SFA 1-2). Marine survival of smolts of both hatchery and wild origin continued to decline in many monitored rivers, even though improved survival had been expected in recent years as a result of reduced marine fisheries.

The salmon stocks in SFAs 1,2, 19-23 and in the USA appear to be at very low levels and the Working Group considered that fishing mortalities on these stocks should be kept as low as possible. The Working Group was made aware of proposals being considered in the USA to prohibit the retention of all angled salmon in 1995.

5.3 Data Deficiencies and Research needs in the NAC area

1. The Working Group recommended that further efforts be made to refine the spawning target estimates. Improvements are needed in the areas of the estimation of suitable habitat, the appropriateness of the habitat specific egg targets, and in the determination of the desired sea-age composition of spawners.

2. The results of monitoring of smolt production and survival from numerous rivers has been useful to the Working Group in the determination of appropriate spawner targets and in investigating and explaining the marine phase of the population dynamics. There are however some areas for which smolt production estimates are not available (e.g. Labrador) and, for areas where there are estimates, they are usually for small rivers or hatchery stocks. It would be useful to expand the enumeration of smolts to other areas and larger rivers.

3. The relationship between air temperature at the time of smolt migration and their subsequent survival from the Conne River was presented at this meeting. Further research into mechanisms accounting for the relationship between environmental and biological characteristics would be useful.

6. GREENLAND COMMISSION AREA

6.1 Description of Fishery at West Greenland 1994

6.1.1 Catch and effort

In accordance with the agreement between the Organisation of Hunters and Fishermen in Greenland and the North Atlantic Salmon Fund, all commercial fishing for salmon in Greenland territorial waters was suspended for the years 1993 and 1994. The agreement allows for a subsistence harvest of 12 tons each year, representing some 4000 fish.

The nominal catches at West Greenland from 1960 to 1994 are given in Table 6.1.1.1, and Table 6.1.1.2 gives the distribution of nominal catches taken by Greenland vessels between 1977 and 1992 by NAFO Divisions according to place landed. No information is available on the 1994 harvest either for the actual catch or the catch composition.

6.1.2 Origin of catches at West Greenland

Salmon catches at West Greenland have historically comprised fish of both North American and European origin in approximately equal proportions, although in 1990 the proportion of North American was estimated to have risen to 75%. As no sampling has been carried out in the area since 1992, it is not possible to assess whether there has been any change in the stock composition.

Harvest of US Salmon at West Greenland

The Working Group considered an update of the time series of Carlin tag recoveries and harvest estimates for Maine-origin 1SW salmon at West Greenland. Tag recoveries and harvest estimates have not been updated for 2SW salmon since there have been no new tag returns.

The updated time series of tag returns for Maine-origin 1SW salmon in West Greenland can be found in Table 6.1.2.1. Returns (to date) for the 1993 fishery total 2 tags. An additional tag was attributed to the 1992 fishery. New data for the 1994 run used to calculate the RATIO parameter and the updated time series of tags and run size in homewaters can be found in Section 5. The estimated harvest of Maine origin 1SW salmon in West Greenland is summarised by year based upon an assumed 85% passage efficiency (Table 6.1.2.2). The harvest estimate for the 1992 fishery totalled 1,067 salmon and was primarily distributed in NAFO divisions 1C, 1E and 1F. The harvest estimate for the 1993 fishery totalled 327 salmon and was attributed to NAFO divisions 1B and 1E. The 1993 season was the first year of the buy-out arrangement in Greenland, thus a sharp decrease in harvest was expected. The Working Group expressed concern over the precision of the harvest estimate for 1993 because it was based on very few tag returns in the fishery and in homewaters. However, other sources of bias identified for the model would tend to increase the harvest estimates.

6.1.3 Exploitation rates at West Greenland

Exploitation of US origin Salmon

Extant and fishery-area exploitation rates for Maine-origin salmon stocks taken in Canadian and Greenland fisheries were updated by the Working Group and presented in Section 5. The values for 1993 must be treated with caution because they are based on very few tag returns. The extant exploitation rate for 1SW Maine origin salmon in 1993 was 30% despite widespread closures of fisheries affecting US stocks. The extant exploitation rate for 2SW salmon has been 0% in the last two years of the time series since no tags have been recovered in distant water fisheries. The fishery area exploitation rate for Maine stocks in Greenland was 38%, at P=0.5, compared to the time series average of 59%.

Extant Exploitation of the North American 2SW Stock Complex

The pre-fishery abundance estimate for the non-maturing (2SW) component of the North American stock complex is derived by summing 1SW catches and 2SW catch and escapement. Extant exploitation (E) for the stock complex is computed by comparing the 1SW catches to the pre-fishery abundance level:

Eq. $$E = (C1(i) + G1(i)) / N1(i)$$

where C1 and G1 are the 1SW catches of non-maturing fish in year i, and N1 is the pre-fishery abundance of the complex in the same year. The time series of these exploitation rates is presented in Figure 6.1.3.1. Exploitation varied between 20 and 50% through the 1992 fishing season. However, with the dramatic reduction of fishing pressure in both Canada and Greenland during the 1993 season, exploitation on the stock complex has declined to less than 5%.

6.2 Status of stocks in the West Greenland area

The salmon caught in the West Greenland area are non-maturing 1SW salmon or older, all of which would return to homewaters in Europe or North America as MSW fish if they survived. The most abundant European stocks in West Greenland are thought to originate from the UK and Ireland. The MSW component of most of these stocks has declined in recent years (see Sections 4.3). Similar declines in abundance have been noted in many North American stocks that contribute to the West Greenland fishery (see Section 5.2). Thus the overall status of the stocks and stock components contributing to the West Greenland fishery remains poor.

6.3 Data Deficiencies and Research Needs in the WGC area

The mean weights, sea ages, and proportion of the fish originating from North America and Europe are essential parameters used by the Working Group to provide catch advice for the West Greenland fishery. As these parameters are known to vary over time (Anon., 1993a) and the latest sampling dates back to 1992, the Working Group strongly recommends that a sampling programme is initiated, as outlined in Anon., 1994a.

7. EVALUATION OF EFFECTS OF MANAGEMENT MEASURES

7.1 Quota and Closures Implemented after 1991 in Canadian salmon Fisheries

In 1992, a five-year moratorium was placed on the commercial Atlantic salmon fishery in insular Newfoundland while in Labrador and Québec North-Shore and Ungava, fishing continued under quota or allowance catch. In conjunction with the commercial salmon moratorium, a commercial licence retirement program went into effect in insular Newfoundland, in SFAs 1, 2 and 14B of Labrador, in Q7, Q8 and a part of Q9 in Québec; there were no changes in the management measures in Q11. The commercial quotas, number of licensed fishermen, and landings are shown below, together with the percentage change in the numbers of fishermen. and the landings from the previous year:

Year	Quota	Licensed fishermen: Number	Licensed fishermen: % change from previous year	Landings: Weight (t)	Landings: % change from previous year
Labrador (t)					
1992	273	495	-13%	204	+70%
1993	178	288	-42%	112	-45%
1994	92	216	-25%	92	-18%
\Ungava (t)					
1992	15	2 bands	0%	2	0%
1993	15	2 bands	0%	2	0%
1994	15	2 bands	0%	3	+50%
Q7-Q9 (number)					
1992	23,400	147	-3%	73	0%
1993	15,325	94	-36%	47	-36%
1994	15,175	90	-4%	47	0%

The moratoria on the commercial cod fishery in 1992, 1993 and 1994 would also have reduced the by-catch of salmon.

The effect of the management measures taken in coastal waters of insular Newfoundland was evaluated by estimating the total returns of salmon to rivers of insular Newfoundland and estimating the numbers of salmon that would not have returned if the management measures had not been taken. For SFAs 3-14A a range in the total returns of small salmon to rivers was estimated by applying exploitation rates of 0.15 and 0.30 to the recreational catches (retained and released) in 1992, 1993, and 1994. The returns of large salmon were then estimated by applying the ratios of large to small salmon as observed at fish counting facilities in 1992, 1993, and 1994 which were 0.138, 0.055, and 0.071, respectively. Finally the numbers of fish released from the fishery were estimated by assuming that the commercial exploitation rate prior to 1992 was about 0.5 for small salmon and 0.7 for large salmon.

The management measurements taken in the Newfoundland commercial fisheries during 1992-94 resulted in the following estimated increases in returns to insular Newfoundland rivers

Year	Angling catch	Total returns	Salmon released due to commercial closure: Small salmon	Salmon released due to commercial closure: Large salmon
	(,000)	(,000)	(,000)	(,000)
1992	37	140-280	62-123	12-24
1993	43	149-300	71-142	5-11
1994	31	112-223	62-104	6-11

The effects of the management changes in Labrador (SFAs 1, 2, & 14B) and Québec North-Shore commercial fisheries are more difficult to evaluate because of the lack of information on escapement to rivers and the low exploitation by the recreational fishery. However, some information can be provided for SFA 2 based on the counting facility at Sandhill River in 1970-73 and 1994. The proportion of large salmon in 1994 was 0.263 which compares to an average of 0.073 for 1970-73, an increase of 260%. Returns to freshwater as a percentage of total production (total production derived from exploitation rates estimated from tagging studies, 1970-73) increased for small salmon from 64% to 90% and for large salmon from 8% to 75%. These changes are mainly attributable to decreases in exploitation due to reductions in fishing effort from the moratorium in Newfoundland, reductions in numbers of fishermen in Labrador, and reductions in quota in Labrador and at West Greenland.

In Labrador (SFAs 1, 2, & 14B), the small reductions in effort in 1992 are unlikely to have reduced the exploitation rate of salmon in the commercial fisheries, which was assumed to be 0.7 - 0.9 for large salmon. Since the quotas were not attained in either 1992 or 1993, this measure did not result in any increase in returns to rivers. However, the combined licensed effort reduction in 1992 and 1993 was 50% of the 1991 licensed effort, which should have reduced the commercial exploitation on Labrador salmon stocks. The changes in the exploitation rate can be estimated from the equation $U = 1-e^{-aF}$, where a = the fraction of the 1991 licensed effort remaining in 1993 and 1994. The new estimate of exploitation would be 0.4 - 0.5 for large salmon in 1993. In 1994, the licensed effort for all of Labrador was 60% of the 1991 level; this should have further reduced the commercial exploitation on Labrador salmon stocks. The new estimate of exploitation would be 0.3 - 0.4 for large salmon in 1994. Thus reductions in commercial licensed effort may have resulted in a doubling of the returns of large salmon to rivers in SFAs 1, 2 and 14B. A similar effect would be expected for small salmon.

The impacts of the commercial fishery moratorium in Newfoundland on river escapement were also assessed by analysing recreational fishery data and counts of small and large salmon at fishways and counting fences. With respect to counts, three years of data are now available for the period of the moratorium. Short term changes in salmon abundance were analysed using a nonparametric randomisation ratio test (Anon. 1993a). The ratio of the means of counts for two periods of time (pre-moratorium and moratorium periods)was compared to determine if the observed value is simply a random ordering of observations achieved by chance, or if the observed value is unlikely (Anon. 1993a). The latter could imply a true change in abundance.

The ratio test was used to compare returns of small and large salmon separately for the pre-moratorium period 1986-91 with returns in 1992-94. Two thousand permutations of the data were run. The results shown in Table 7.1.1 suggest the probability of the observed ratio of 1.77 for returns of small salmon is about 0.0085. This implies that, collectively over all rivers, there was a significant increase in small salmon returns during the moratorium years 1992-94 compared to the pre-moratorium period 1986-91. A separate analysis of Northern Peninsula and Eastern rivers (Torrent River, Western Arm Brook, Exploits River, Gander River, Middle Brook, and Terra Nova River) gave a similar result. For Southern rivers (Biscay Bay, Northeast River (Placentia), Northeast Brook (Trepassey) and Conne River), there was no significant improvement in returns of small salmon for moratorium years over pre-moratorium years. Returns of large salmon for all rivers collectively also increased significantly during the three moratorium years as did those of Northern Peninsula and Eastern rivers (Table 7.1.1). The result for Southern rivers was not significant. Some of the strongest declines in returns of small and large for South Coast rivers occurred in Conne River. If the count of large salmon for Conne River is omitted from the analysis, a significant result is obtained. Omitting Conne River small salmon, however, still produced a non-significant result.

Counts of small and large salmon for these rivers were also compared on an individual river basis. Comparisons of mean counts were made between the same moratorium and pre-moratorium periods using the GLM Procedure of SAS (SAS Institute 1985). Analyses were performed on rank transformed data using the Rank Procedure of SAS. Comparisons of mean counts of small and large salmon for the same moratorium and pre-moratorium periods on an individual river basis are shown in Table 7.1.2. The outcome was similar to that of the separate collective analysis for Northern Peninsula and Eastern and South divisions presented above. It should be noted that all salmon counts decreased except for small and large salmon for Northeast River (Placentia) and large salmon for Rocky River.

While returns of large salmon showed an overall improvement in 1992-94 compared to the 1986-91 mean, for several Northern and Eastern and Southern counting facilities, there were pre-salmon moratorium years when returns were higher. Numbers of large salmon released in SFAs 12, 13, and 14A during the moratorium years showed a marked increase over the means overall but they were still comparable to catches in the late 1970s and early 1980s. For all Northern and Eastern counting facilities except Lomond River and the Gander River counting fence, the proportion of large salmon in all three years of the moratorium were higher than the 1984-1989 and 1986-91 means. This was also the case for three out of five Southern counting facilities.

The time series of smolt survival rates from Western Arm Brook, Newfoundland divided into pre-moratorium (1987-91) and post-moratorium years (1992-94) was analysed to show the effects of the commercial fishing moratorium on a Newfoundland stock (Figure 7.1.1). The range of survival rates in pre-moratorium years was 1.5 to 3.0% while in post-moratorium years the range in survival rates doubled to 3.6 to 7.01%. If it is assumed that natural mortality remained constant between pre- and post- moratorium years, this analysis suggests that exploitation rates on Western Arm Brook salmon in the Newfoundland and Labrador commercial fishery had been approximately 60%.

In zones Q7 and Q8, the commercial exploitation rate in 1990 - 1992 was calculated to be 3% - 4% for small salmon and 26% - 33% for large salmon. The closure of the fishery in 1994 may have resulted in 29 to 43 small salmon and 713 to 905 large salmon not being caught assuming that the exploitation rates in 1994 would have been the same as in 1990-92 if there had been no management change.

The analysis of the 22 year time series of biological characteristics of Atlantic salmon from the Miramichi River has shown that when size-selective commercial fisheries are closed, there is an observed increase in the size-at-age and in the proportion of previously spawned 1SW and 2SW salmon in the returns to the Miramichi River. Prior to 1984, the survival to a second spawning migration of 2SW maiden salmon varied between almost 0% to 7% (Figure 7.1.2). The survival increased to between 5% and 15% when hook and release regulations were introduced into the recreational fisheries and when coastal commercial fisheries in the Maritimes were closed. The survival of 2SW maiden salmon of the 1989 spawning migration increased to more than 30%; this group of fish was exposed to reduced exploitation in

Newfoundland and Labrador as a result of the quota restrictions of 1990 and 1991. The 1990 spawning migration of 2SW maiden salmon had a survival to a second spawning of about 33%; the survival of this group would have been improved by the quota restriction in the 1991 Newfoundland fishery and the commercial salmon moratorium of 1992. Survival of 1SW maiden salmon has not changed because of the continued exploitation of this group in the recreational fishery of the Miramichi River.

Although the Newfoundland and Labrador commercial salmon fisheries used to harvest small and large salmon originating in Nova Scotia, New Brunswick, Québec, and USA the benefits in returns to these provinces cannot be quantified.

7.2 Suspension of Commercial Fishing Activity at Faroes

7.2.1 Effects on levels of exploitation on monitored stocks

Since 1991, the Faroese quota has been bought out by various interested parties. As a result, no commercial fishing has taken place in the 1991/92 to 1994/95 seasons, but research fishing has been conducted under the direction of the Faroese Fisheries laboratory.

Assuming that monitored stocks have been relatively stable over the past five years, the suspension of commercial fishing should have reduced exploitation at Faroes to less than 10% of levels in the previous three seasons. For stocks in UK and Ireland the numbers of tag recoveries at Faroes in the last four seasons have been too low for such a reduction to be shown statistically. However, mean levels of exploitation on 2SW fish from R. Imsa (Norway) (hatchery and wild fish) and R. Lagan (Sweden) (hatchery fish) decreased from 18% in the 1988/89 to 1990/91 seasons to 5% in the 1991/92 and 1993/94 seasons; this reduction was significant when tested by the Randomisation method (Rcrit = 0.284, p = 0.003).

7.2.2 Reduction in homewater catches if full Faroese quota had been taken

The Working Group used the model developed in 1994 (Anon, 1994a) to estimate the reduction in returns to homewaters that might have been expected if the full Faroese quota had been taken. The numbers of fish that would have been landed if the full quota had been taken were estimated by dividing the quota (550 t) by the mean weight of fish caught in the research fishery. The age composition, discard rates and proportions of farm-origin fish from the research catches (Tables 4.1.2.3, 4.1.4.2 and 4.1.4.4) were used to estimate the additional numbers of fish that might have been killed each season if the commercial fishery had operated, assuming an 80% mortality rate for the discards (Anon, 1987). This suggests that an average of about 118,000 (96,000 to 153,000) extra wild and 42,000 (32,000 to 57,000) extra farm-origin salmon could have been killed in each of the three seasons (Table 7.2.2.1).

The Working Group has previously provided a model to assess the effects of the catch at Faroes on stocks returning to homewaters (Anon., 1984). It has been estimated that 78% of the 1SW and 2SW fish (and 100% of older fish) in the Faroes area will mature in the same year and it is assumed that 97% of these will survive to reach home waters if they are not caught (assuming M=0.01 per month). The remaining 1SW and 2SW fish are assumed to mature in the following year, with 86% surviving to return to home waters.

Using these figures, it is estimated that returns of wild fish to homewaters could have been reduced by 9,000 1SW, 48,000 2SW and 39,000 older fish in 1993 if the full quota had been taken in the 1991/92 to 1993/94 seasons (Table 7.2.2.1). These figures differ slightly from those given in Anon (1994a), reflecting minor changes in the data used. In 1994, returns could have been reduced by about 19,000 1SW, 77,000 2SW and 40,000 older fish (Table 7.2.2.1).

The analysis also suggests that the fishery would have caught an extra 126,000 fish farm-origin fish if the full quota had been taken in the 1991/92 to 1993/94 seasons.

7.2.3 Expected increase in returns to homewaters

In 1994, the Working Group used a second model to estimate the expected increase in homewater catches following the quota buy-out (Anon, 1994a). This model compared the catches made by the research vessel with the average catch in the commercial fishery in the three seasons prior to the buy-out. The Working Group modified this model to take account of changes in CPUE in the research fishery. Thus the expected catch (C_i) in season 'i' (since 1991/92) was estimated to be:

C_i = (CPUE in season 'i') * (Mean effort in 1988/89 to 1990/91 seasons)

The effort in each season 'j' between 1988/89-1990/91 was estimated to be:

(effort in season 'j') = (catch in season 'j') / (CPUE in season 'j')

This approach assumes that the total effort would have remained constant between seasons. It should be noted, therefore, that changes in CPUE might also have affected the fishing effort.

The numbers of fish killed in the research fishery in the seasons were 8464, 5415 and 2072 respectively. The proportion of these catches that were of farmed origin has been estimated by scale analysis (Table 4.1.4.2). These data have been used to divide the catches in the commercial fishery (1988/89-1990/91 seasons) and the research fishery (1991/92-1993/94) seasons into wild and farmed components (Table 7.2.3.1).

The mean effort in the 1988/89 to 1990/91 seasons (as defined above) was 1236 hook.days. The catch that would have been expected to have been landed in the subsequent seasons is thus calculated as explained above. This figure is further raised to take account of discard mortality. The discard rate was obtained from the proportion of the research vessel catches that were below the minimum landing size of 60 cm (total length)(Table 4.1.2.3), and the mortality rate for these fish was assumed to be 80% (Anon., 1987). The number of fish that were expected to have been killed in each season is thus shown in Table 7.2.3.1. Multiplying these numbers by the mean weights of fish caught in the research fishery gives an estimate of the total catch that might have been taken in these three seasons if the fishery had operated at the same level as in the preceding years; these were 385 t, 475 t and 199 t in 1991/92, 1992/93 and 1993/94 respectively.

The total numbers of wild and farmed fish estimated to have been saved from the fishery by the buy-out in these three seasons is thus estimated by subtracting the research vessel catches from the 'expected' catch. Assuming the same proportions of the fish survive and return to homewaters as given above (Section 7.2.2), an additional 71,000 wild fish are estimated to have returned to home waters in 1993 as a result of the buy-out and an additional 51,000 wild fish in 1994 (Table 7.2.3.1). The revised estimate for 1993 is rather higher than that given in Anon (1994a) reflecting the effect of taking account of the increased CPUE in the 1991/92 and 1992/93 seasons. However the estimates for 1994 are lower than this because of the reduced CPUE in the 1993/94 season.

On the basis of the age composition of catches taken in the research fishery (Table 4.1.4.4) it is estimated that the majority (~95%) of the fish saved from the fishery would be MSW salmon. These fish will probably have contributed to homewater fisheries in most salmon producing countries in the north-east Atlantic. The majority (perhaps 60-80%) of the wild fish caught at Faroes are thought to originate from Scandinavian, Finnish and Russian stocks (Anon., 1991, 1992, and Section 4.1.5) and thus the greatest impact should be seen in the fisheries of these countries. The assessment presented in Section 8.2.4 of this report presents a method for estimating the numbers of MSW salmon returning to home waters in these countries. The estimates for 1993 and 1994 were 432,304 to 761,511 and 353,497 to 688,881 respectively, and this therefore allows the estimated increase in MSW salmon stocks to be expressed as percentages as shown below

Year	Age	Increase in total returns	Estimated increase in stock s in Scandinavia, Finland and Russia	
			Number	%
1993	1SW	4,000	2,400-3,200	<1%
	MSW	67,000	40,200-53,600	5% - 12%
1994	1SW	3,000	1,800-2,400	<1%
	MSW	49,000	29,400-39,200	4% - 11%

The increases in the catches of wild fish are within the annual variation of catches in these countries and do not represent a statistically significant increase. This was confirmed using the Randomisation test; there were no significant changes in the catches for Ireland, Scotland (large salmon) and Russia (2SW salmon) in 1992-1994 compared with those in 1987-1991 (Rcrit = 0.745, p = 0.846), or for 7 Russian rivers in the same two periods (Rcrit = 0.958, p = 0.472.)

Exploitation rates on stocks from UK and Ireland have been very low at Faroes in most years. The buy-out of the quota must be expected to have resulted in additional fish returning to these countries, but the predicted improvements in catches will be very small. In view of the variability of homewater catches, it is not expected that it will be possible to show a statistically significant increase even after many years.

7.3 Suspension of Commercial Fishing Activity at West Greenland

The West Greenland fishery captures salmon in the calendar year before they return to home waters. It is not possible to evaluate the effects of the suspension of commercial fishing activity in 1994 as fish which were in West Greenland waters will not be detected in home waters until 1995.

Only one year of the suspension of fishing activity can therefore be assessed, that is 1993. The quota agreed at NASCO in 1993 for this fishery was 213 t, based on a mid-point in the pre-fishery abundance estimate of North American 1SW fish of 258,000 (the mid-point of the actual abundance was 150,470 - see section 9.1.2). Although the pre-fishery abundance was very low, it was felt to be a reasonable assumption that the fishery could have harvested a catch of 213 t in 1993 because in 1992, when the mid-point of the pre-fishery abundance was 177,569, a catch of 237 t was taken.

The method of assessment was to estimate the harvest that would have taken place if the fishery had caught

213 t and to compare this level of harvest to estimated returns to North American and European waters.

The parameters for biological characteristics which were forecast for 1993 (we do not know actual values as no sampling of the populations of salmon in West Greenland waters occurred in 1993) were:

PropNA	0.540
WT1SWNA	2.525
WT1SWNE	2.660
ACF	1.121

Of a catch of 213 t, a portion would have been 2SW and repeat spawning salmon, accounted for by the ACF factor. Therefore the weight of 1SW salmon in a 213 t catch would be 213,000 kg/ 1.121 = 187,227 kg.

The combined mean weight of North American and European 1SW salmon would have been (0.54*2.525 + 0.46*2.660) = 2.5871 kg. Therefore the number of 1SW fish that would have been caught was 187,227/2.5871 = 72,369. Using the proportions above, this would have meant a catch of 39,080 North American and 33,289 European 1SW salmon. As these fish were not caught, they would have spent an average of a further 11 months in the sea, at assumed mortality levels of 1% per month. This would mean that there would have been about 39,080/1.1163 = 35,009 additional North American and 33,289/1.1163 = 29,821 additional European 2SW salmon returning to homewaters.

In North America, the estimated numbers of 2SW salmon in the fisheries and in returns to rivers were 10,649 to 13,692 and 77,089 to 162,743 respectively (see Table 9.1.2.2). The 2SW salmon estimated to have returned to North American waters (35,009) as a result of the closure of the Greenland fishery in 1993 therefore represented between 20 to 40 % of the total 2SW return of 87,738 to 176,435.

European origin salmon not caught at West Greenland in 1993 would be expected to return mainly to southern European countries (UK, Ireland and France). If it is assumed that 29,821 European origin 2SW salmon returned in 1994, and that approximately 30% homewater exploitation pertained, the number of them caught (8,946) would have represented some 6.4% of the declared 2SW catch in those countries (140,736 fish). This increase in catch is well within observed ranges of catch variation.

Alternatively, the hypothesised number of 2SW European origin fish returning from West Greenland in 1994 represented between 3.0% and 7.7% of the total 2SW stock estimated to have returned to southern European waters (384,550-1,002,234 2SW fish; see Section 8.2.1).

8. ASSESSMENT ADVICE FOR THE NORTH-EAST ATLANTIC COMMISSION AREA

8.1 Estimates of Spawning Targets for Optimal Production

8.1.1 Definition of stock targets

Following the recommendations of the Workshop on Salmon Spawning Targets in the North-East Atlantic held in Bushmills in 1993 (Anon., 1994a) the Working Group agreed that spawning targets would best be derived from stock and recruitment data.

Where stock-recruitment data are available, different models (e.g.: linear, log, Beverton and Holt, Ricker, etc.) should be fitted to the data. After choosing a model which appropriately (i.e. statistically) describes the stock-recruitment relationship, the stock and the recruitment should ideally be expressed in the same units so that gain (where gain equals the recruitment minus the stock producing that recruitment) can be calculated. For instance, if stock is expressed in eggs and recruitment is measured by smolt numbers, smolts can be converted into potential egg production by using information on sea survival, sex ratio and mean fecundity per female. It is noted however that in some cases uncertainties about factors needed to carry recruitment estimates through to adults or eggs, mean that it will only be possible to identify the level of stock that maximises freshwater recruitment (as parr or smolts). In such cases the concept of gain will not apply. Once such a conversion is done, a gain curve can be derived. On this curve, two stock reference points can clearly be defined:

(i) the point of maximum gain (MG) and

(ii) the replacement point (i.e. gain = 0).

(Note: an over-compensation type curve, e.g. Ricker, has a third definable reference point, which is the spawner level which generates maximum recruitment, but other curves, such as the Beverton and Holt curve, will not. This is always equal to or greater than the spawners required for maximum gain. The extent of this difference will depend on the initial productivity of the stock).

An example of such an analysis carried out on the River Bush (UK, N. Ireland) data is given in Figure 8.1.1.1. A number of statistical models were applied to these data. Based on the associated regression statistics (r and p), the best fit was obtained using a Ricker model. For this river, reference points calculated from a lognormal fit of the Ricker curve to the stock/recruitment data yield the point of maximum gain (spawner level that generates maximum surplus recruitment) at 2.31 million eggs and the replacement point at 7.34 million eggs. These reference points can be regarded as the lower and upper bounds of target spawning requirement. Somewhere between the lower limit (MG) and upper limit (replacement) will lie an optimum which will minimise the risk of recruitment over-fishing while maximising the gain. The lower recruitment reference point (MG) has been adopted by the Working Group as an objective standard spawning target and equates to the minimal biologically acceptable level (MBAL), as defined by the ICES Working Group on Methods of Fish Stock Assessment (Anon. 1993c). It should be stressed that this agreed reference point is not the target reference point applicable to management, as it takes no account of risk of not achieving target. It is accordingly the minimum desired biological point for a stock.

Ideally, stocks should be managed in order to maintain them at or close to the level corresponding to maximum gain, thus providing the best opportunities to maximise the harvest and to maintain stock viability in the long term. In order to avoid falling below this point because of variability in recruitment and exploitation rates, a target should be set at some level above the maximum gain (MG) level. This centres on looking for a compromise between the risk of falling below maximum gain and the potential loss of harvest opportunities. The exact location of the target is an issue which should be considered locally by biologists and managers, as variability around the stock/recruitment relationship, variability in biological parameters (e.g. fecundity in different stock components) and feasibility of managing fisheries to allow achievement of target levels must all be considered. A related issue arises from the use of targets generated in one river system to set targets for groups of stocks or stock complexes, as the range of productivity of these stocks must be considered, so as to afford protection for low productivity stocks.

It is noted that various approaches can be used to help objective setting of "risk averse" targets, such as setting the target at an egg deposition level above the point of maximum gain where a given percentage (say 90%) of the maximum will be achieved. This would involve a trade-off; sacrificing a proportion of catch to achieve a buffer against recruitment over-fishing. In the case of the R. Bush, this point would fall at a target level of 3.38 million eggs, the extra 1.07 million eggs acting as a buffer against poor natural survival (freshwater or marine) or over-exploitation. Managers should also address the issue of catch allocation once a total allowable catch (TAC) (consistent with achieving target) for a stock or stock complex is decided. If a proportion of the harvestable surplus is allocated to in-river rod fisheries the possibility that these fisheries will be unable to take their allocation (e.g. due to fishing conditions) must be appraised. This circumstance may be regarded by many managers as providing a desirable extra buffer.

For rivers where no clear stock-recruitment relationship can be fitted or where no stock-recruitment data are available, it may still be possible to derive a spawning target following the principles defined by ICES (Anon., 1993). For example, if on a historical data series recruitment has not been limited by spawner numbers, as for the N. Esk (UK, Scotland), then MBAL can be defined at the lowest previously recorded spawning level. Clearly, to allow recruitment below this point would be operating in an area of biological uncertainty. This approach can only be applied if the observed spawning escapement is spread over a wide range around mean escapement, as a narrow range of observed spawners cannot form a basis for identifying MBAL, especially if recruitment was also observed to vary widely. Again, this does not equate to a management target, and the issues raised above need consideration.

Where insufficient stock-recruitment data are available, target spawning levels must be derived using data from other rivers in the same geographic area or with similar environmental characteristics. The Working Group recognised that this presented considerable problems in some areas and noted the need for further consideration of these problems which might be addressed by a Workshop.

8.1.2 Development of spawning targets in the NEAC area

In 1994, the Working Group agreed to provide provisional spawning targets for at least one river per country in the North-East Atlantic area. The following section presents the data provided to the group for several monitored rivers. Egg deposition targets are proposed for some of them according to the principles defined in Section 8.1.1. Data on targets and historical achievement with respect to targets for various rivers in the north-east Atlantic are presented in Section 4.3.1.

France: A first attempt was made to derive a spawning target from the information collected on the Oir (spawning tributary of the Sélune R., Normandy) since 1984. Each year, egg deposition (stock) and smolt production (recruitment) were estimated from upstream and downstream trapping data. Both Ricker and Beverton and Holt stock/recruitment models were used (r^2 = 0.73 and 0.75). They gave similar results in terms of the shape of the curves and the quality of the fit to the data. For the Ricker model, maximum smolt production was obtained at an egg deposition of 2350 egg/100m² of juvenile rearing habitat (shallow rapids and riffles).

However, the Oir has very low productivity, due to poor survival from egg to smolt, believed to be a consequence of the impact of agricultural practices in the watershed, leading to high levels of fine sediments in the river. It was therefore concluded that the Oir could not be used as a reference system for setting targets of egg deposition for salmon populations in France.

Over the next decade, until the stock/recruitment data being collected on the Scorff (Brittany) can be utilised to develop a preliminary target from a French monitored river, the Bush R. data (UK, N Ireland) will be used to develop working targets for the salmon rivers in France. Due to its catchment and stock characteristics, the Bush R. seems to be the most appropriate data set available at the moment for French stocks, at least from Brittany and Normandy.

When feasible, it would be useful to roughly evaluate the implications, in the context of French rivers, of choosing the target derived from the Bush data. Using estimates of maximum production (such as maximum number of smolts potentially produced), it is possible to get the equation of the stock/recruitment relationship (under different models) in accordance with the spawning target selected. The likelihood of such a relationship can be assessed by comparing the predictions it makes with complementary data collected from the river system considered (range of survival from egg to smolt, size of the runs, juvenile densities.). A first attempt at such an analysis was conducted for the Scorff R. (Brittany). It suggested that the range of egg deposition for maximum smolt production proposed for the Bush R. would not be inappropriate for the Scorff.

Finland: In Finland, stock/recruitment data are unavailable to assist with setting salmon spawning targets; however in the Teno and other rivers, annual surveys of juvenile densities are used to assess stock levels. These data are used as recruitment indices to allow assessment with respect to previous attainment.

Iceland: The data from the River Nordura had been used to consider spawner to spawner relationships at the 1994 Working Group meeting, in order to investigate recruitment over-fishing. These data indicated that both grilse (1SW) and 2SW spawners were in a stable state and it was considered desirable to work out a spawner-recruit relationship for the river by combining year-classes. It is intended that data for such analysis for the Nordura and possibly other Icelandic stocks should be brought to the 1996 Working Group meeting.

Ireland: Recruitment data for the Burrishoole indicated two or possibly three separate stock recruitment curves - from 1972 to 1979, 1980 to 1987 and from 1988 to 1993 (Anon 1994b). The possible reasons for three relationships in the same stock over time may include a known significant loss in the lacustrine component of the catchment to salmon production due to deterioration in water quality in the system, and possible input from the ranched component of the stock in the later years. Therefore, the data were examined in two ways:

a) Taking the overall series of data without reference to the changes observed in the time series.

b) Using the most recent identifiable relationship which appears to reflect the actual stock situation in recent years.

A Ricker model fitted to the data shows a maximum smolt output produced from 3,856 adults (2,314 females). Based on typical salmonid fluvial habitat and an average fecundity of 3,500 eggs, the total egg deposition required for the system is 8 million eggs or 7,670 eggs.100m^{-2} (fluvial habitat). Fitting a Beverton and Holt model yields similar but lower estimates of spawners required to achieve maximum smolt production at 2,536 adults (1,522 females). This translates to an egg deposition of 5.3 million eggs required for the system (5,000 eggs.100m^{-2}).

Examination of 1SW adult to adult returns lagged by four years (based on the assumption that the majority of smolts are 2 years old) indicates that the number of spawners providing the maximum observed adult recruitment was 1,387 (832 females). An egg deposition of 2.9 million (2,759 eggs.100m^{-2}) could have resulted from this level of spawners.

Since 1979, the average spawning run of salmon to the Burrishoole was 600 fish. Applying a Ricker model the more recent data suggest that 616 adult spawners (370 females) are required to produce maximum smolt output. This translates to 1.3 million eggs (1,225 eggs.100m^{-2}). The Beverton and Holt type model produces lower estimates using these data.

All of these estimates are above the Canadian target estimate of 240 eggs.100m^{-2} used in Canadian rivers. The target data from the River Bush grade 'A' habitat (Anon 1994b) applied to typical juvenile salmonid habitat in the Burrishoole produces estimates similar to those produced by the Ricker model for the recent period data set. However, if targets based on the recent Burrishoole and/or Bush data are applied, the system will continue to produce at below replacement level in relation to historical attainment, as the long time series has indicated that the Burrishoole is capable of supporting a higher spawning population than that of recent years. This suggests that the lakes were contributing significantly to overall production in the past.

In order to transport a Burrishoole derived target value to other Irish rivers, it is necessary to express it relative to the habitat area. It is suggested that, in the interim, the River Burrishoole fluvial and Bush targets of approximately 1,000 eggs.100m^{-2} may be applicable to other river systems with predominantly fluvial habitat, provided suitable habitat data are available. For this it will be necessary to define standard habitat types, e.g. fluvial habitat, lake habitat, suitable habitats etc, which can be measured in other rivers in a uniform manner.

Norway: A preliminary assessment of the stock-recruitment relationship for the River Imsa suggests that egg deposition of between 800 and 1000 eggs.100m^{-2} of total wetted area available to juveniles would maximise smolt output. A whole river target for the R Imsa is not available and habitat measurements on other rivers still have to be carried out before Imsa or other data can be transported for target purposes.

Russia: A salmon spawning target has been set for the Tuloma river, based on stock/recruitment data (Anon., 1989a; Working Doc. 31), with 830 1SW and 3530 MSW spawners required, making a total target egg deposition of 42.19 million eggs. This target has not yet been transported to other rivers. Time series data for target attainment for the Tuloma R. are given in Section 4.3.1.

Sweden: Work on establishing spawning stock targets in the major Swedish river (River Hogvadsan, a tributary of the river Atran) carrying wild salmon was initiated during 1994. The inconsistency in older data means that the work will have to be continued for a number of years before a spawning stock target can be established.

UK (England and Wales): The National Rivers Authority (NRA) has established preliminary spawning targets for all salmon rivers in Wales as a basis for evaluating the renewal of regulations limiting the number of nets that may be licensed to operate in each estuary or coastal area. These targets have been based on the egg deposition required to maximise smolt output on the River Bush, N. Ireland, which is felt to be the nearest system that gives data applicable to Welsh rivers. The NRA have used a target egg deposition of 390 eggs.100m^{-2}, which is the lower limit of the range (390-580 eggs.100m^{-2}) given by Kennedy and Crozier (1993) for optimal egg deposition based on useable juvenile habitat in the Bush. However, the River Bush stock-recruitment relationship was reviewed during the meeting in the light of the Working Group's revised definition of minimum acceptable spawning levels. This gave a required egg deposition for maximum net gain of 563 eggs.100m^{-2} of useable habitat in the River Bush.

The Working Group has applied the revised target, based on the latest information, to the River Dee (Wales). Habitat mapping was carried out by classifying the stretches of river used by salmon into three categories and estimating the area. The habitat categories were: non-salmonid habitat, which would not be expected to contain any juvenile salmonid; moderate rearing habitat, which would be expected to contain low to moderate densities (0-30 eggs.100m^{-2}) of salmon; and good rearing habitat, which would be expected to contain moderate to good populations of juvenile salmon (>30 eggs.100m^{-2}). The total area of moderate and good habitat was used to assess the required egg deposition.

Attainment of the target levels has been assessed by trapping and tagging studies. Spawning escapement in the years 1992-94 has been estimated by marking upstream migrants at the tidal limit and recovering tags in the rod fishery. Sex ratios have been estimated from external examination of adult fish, and egg production from length:fecundity relationships. Results of these studies are presented in Section 4.3.

UK (N. Ireland): Salmon spawning target data are available for the R. Bush, based on a long term whole river stock/recruitment study (Kennedy & Crozier, 1993). Egg deposition data are derived from numbers of adults released upstream from the trap, corrected for sex ratio, fecundity and upstream angling and other mortality. Recruitment has been initially measured in terms of smolt production (from total trapping), but has been carried through to resultant eggs by applying typical values for smolt to adult survival, fecundity and sex ratio. Applying a Lognormal Ricker curve to the resultant egg to egg relationship (Section 8.1.1) allows identification of reference points. The standard reference point of Maximum Gain occurs at 2.31 million eggs, while maximum recruitment occurs at 2.74 million eggs. The difference in egg yield at the two reference points is minimal on this river. Assuming that the majority of egg deposition on the R. Bush is achieved by 1SW fish (fecundity 3400 eggs per fish), the target is equivalent to approximately 679 spawning females. At an approximate 60% female representation, this implies a requirement of 1312 spawners.

At present, only the R. Bush spawning target is provided for UK (N. Ireland); however, availability of habitat data for the R. Bush means that the whole river target can be expressed on a per unit habitat basis, for transport to other rivers:

Habitat type	Area in R. Bush(ha)	Target egg deposition(eggs 100m-2)
a) Total wetted surface	84.55	273
b) Total useable salmonid nursery habitat	41.06	563
c) Total useable grade 'A' salmonid nursery habitat	23.38	988
d) Total useable grade 'A' normally used	16.91	1366

It is hoped that spawning targets (and historical attainment) will be presented for several UK (N. Ireland) rivers next year, based on transport of Bush data.

UK (Scotland): The only data available from a complete river system for Scotland are those from the North Esk. Egg deposition was calculated by:

- estimating the numbers of spawners from counts of fish recorded at Logie on the North Esk, minus rod catches taken upstream,
- spawners were assigned to sea age classes, size groups and sexes by reference to catch sampling and close season sampling data,
- fecundity relationships for early-running and late-running fish in both 1SW and MSW groups were determined and applied to the female spawner numbers.

It has not been possible to determine a stock-recruitment relationship because in the time period examined production in the river system has never been limited by egg deposition. Thus, the level of MBAL chosen was the lowest number of spawners (and eggs) observed during the time series: 2334 1SW, 1658 MSW representing a target egg deposition of 12,775,622 eggs. When divided by the area of total wetted surface accessible to salmon, it translates to 687 eggs.100m^{-2} . At present it is not known whether this target is applicable to other rivers in Scotland.

8.2 Methods for Providing Advice on Catch Quotas in Relation to Stock Abundance

8.2.1 Framework for developing catch advice in the NEAC area

The Working Group was asked to develop methods which could be used in providing advice on catch options in relation to stock abundance in the NEAC area. Such methods are likely to depend upon adopting a similar approach to that used for the provision of catch advice for the West Greenland fishery since 1993. This has been based upon a target for the minimum number of 2SW spawners required in North American rivers and a method for forecasting the numbers of fish available in the sea prior to the fishery. Forecasting the number of European fish available to the fisheries depends first upon developing a time series of historic data on the abundance of salmon from rivers in the NEAC area and then on finding environmental or biological factors that can be used to develop a predictive model.

The rationale behind this approach has been discussed in some detail in past reports of the Working Group (Anon 1984a, 1986a, 1988a, 1993a and 1994a). In addition the Working Group has pointed out the risks to individual stocks involved in basing management decisions on data for a number of stocks combined. It was noted that the implication of these factors had not been fully explored for the management of European stocks, where the patterns of movements of fish between areas and the interaction between fisheries may be more complex than in the North American and West Greenland Commission Areas.

8.2.2 Spawning targets for the NEAC area

The Working Group has made some advances with the development of spawning targets in the NEAC area and these are reported in Section 8.1; targets have also been used to provide advice on the status of stocks for the first time in Section 4.3. However, in order for spawning targets to be used to provide catch advice they will have to be prepared for all stocks in the NEAC area (or all those affected by a particular fishery, if appropriate stock complexes can be defined). The Working Group noted that while some countries may be able to define targets for all their rivers within 1-2 years, other countries may have great difficulty in developing them in less than 5 years. The Working Group therefore recommended that members should establish preliminary spawning targets for all their rivers as soon as possible.

8.2.3 Pre-fishery abundance estimates for the NEAC area

In 1994, the Working Group recommended that the following procedure should be followed in the development of abundance estimates in the NEAC area:

a) pre-fishery abundance estimates should be developed for salmon stocks in all European countries;

b) consideration should be given to developing predictive models for at least two stock complexes within the North-east Atlantic;

c) consideration should be given to developing separate models for 1SW fish and spring returning and summer returning MSW fish where appropriate.

The Working Group prepared a preliminary analysis of this type during the meeting. Estimates of pre-fishery abundance were compiled based on the catch in numbers of 1SW and MSW salmon in each country. These were raised to take account of minimum and maximum estimates (or guess-estimates) of non-reported catches, and exploitation rates on the two age classes. Finally they were raised to take account of natural mortality between the end of the first sea winter and the mid-point of the national fisheries.

Thus the minimum and maximum estimates of pre-fishery abundance for each age class in each country were estimated as follows:

$$PFA_{i(min)} = C_i \ / \ (1 - R_{i(min)}) \ / \ E_{i(max)}) \ / \ S_i$$

and $$PFA_{i(max)} = C_i \ / \ (1 - R_{i(max)}) \ / \ E_{i(min)} \ / \ S_i$$

where: C_i = catch in numbers of sea age 'i' salmon

$R_{i(min)}$ and $R_{i(max)}$ = minimum and maximum guess-estimates of the proportion of the total catch of age 'i' salmon that is unreported.

$E_{i(min)}$ and $E_{i(max)}$ = minimum and maximum estimates of the average level of exploitation on age 'i' salmon in the country.

S_i = survival from beginning of first sea winter to mid point of homewater fishery for age 'i' salmon (assuming M = 0.01 per month)

These data were combined for all countries to obtain overall minimum and maximum estimates of the pre-fishery abundance of maturing and non-maturing 1SW salmon in the NEAC area. Data were available for all countries from 1981 to 1994 (and some for countries for longer periods); the combined data for 1981-94 are given in Table 8.2.3.1 and Figure 8.2.3.1. The data have also been combined for two European stock complexes comprised as follows:

Southern European stock complex:	Northern European stock complex:
Ireland	Iceland
France	Finland
UK(England & Wales)	Norway
UK(Northern Ireland)	Russia
UK(Scotland)	Sweden

Because the majority of fish taken in the Faroes area are thought to originate from Scandinavia, Russia and Finland, the abundance estimates derived from the Faroese catches were included in this stock complex. Similarly, the European component of catches from West Greenland were included in the Southern European stock complex. The pre-fishery abundance estimates for the two stock complexes are shown in Tables 8.2.3.2 and 8.2.3.3 and Figures 8.2.3.2 and 8.2.3.3.

The above division is based mainly on the simplest geographic division of national groups. It was noted however that this separation might need to be refined, particularly to take account of the origin of catches at West Greenland and Faroes. In addition, catch figures from Norway and Scotland are highly correlated (see Section 8.2.2) suggesting that Scottish stocks may be more closely aligned with the Northern European stock complex than the Southern group.

The Working Group noted that the range of these preliminary estimates of pre-fishery abundance are very wide and considered that it would be inappropriate to pursue analyses using the mid-point of the range until they had been refined. However, the figures show some interesting features. In the Northern stock complex, the number of maturing 1SW recruits appears to have increased in the early 1980s but has probably remained fairly stable since then (Figure 8.2.3.1). However, the non-maturing 1SW component appears to have declined rapidly from a stable level in the period 1981-85 to a lower level in the period 1988-93. This pattern is somewhat different to that observed for the Southern stock complex (Figure 8.2.3.2). Here the maturing 1SW component appears to have increased in the early 1980s, but then declined again possibly reaching a minimum in 1989, a year when post-smolt survival was reported to be low in the NEAC area (Anon, 1991). The abundance of non-maturing 1SW salmon in this stock complex appears to have declined steadily during the 1980s, which agrees with observations previously made of the numbers of non-maturing 1SW European fish at West Greenland (Anon, 1992a).

The Working Group were encouraged by this preliminary analysis and recommended that work should be carried out to refine and analyse the variability of the estimates before the 1996 meeting. In particular it was suggested that members could attempt to provide separate data sets for different parts of their country and that changes in exploitation rates could be estimated by examining effort data.

8.2.4 Development of predictive models for the NEAC area

In the absence of a fully developed time series of pre-fishery abundance data the Working Group were unable to test any predictive models for total stocks. However, the Working Group considered analyses exploring the potential predictive capabilities of both environmental and biological parameters for stocks in the NEAC area.

At its meeting in 1994, the Working Group examined the possibility of predictive relationships existing between marine conditions and marine survival of the salmon stock from the River Figgjo in Norway (Anon 1994a). They continued to develop this model by comparing marine survival data for salmon from the River Figgjo and from the North Esk in Scotland. If the main driving force behind the mortality is related to temperature, one should expect that survival of salmon stocks migrating as post-smolts into the same areas will be correlated. Crozier and Kennedy (1993) showed such a correlation in survival rates to the Irish coast of 1SW hatchery-reared fish from the River Bush and River Burrishoole. Long-time series of wild smolt tagging are available from the River Figgjo, Norway and the North Esk, Scotland. These rivers enter opposite sides of the North Sea at about the same latitude, and because salmon from these two rivers are observed in the Faroes fisheries at the same time, it is reasonable to assume that these salmon stocks at least for the first months in the sea are subjected to the same marine environmental conditions. Smolts from both stocks migrate to sea at approximately the same time in early May.

The Working Group also examined the relationship between catches in Norway and Scotland. Nominal catches may be crude estimates of relative abundance of salmon. If nominal catches are related to survival from smolts to adults, it may also be hypothesised that a significant part of the mortality of salmon originating from larger areas are driven by the same mortality factors.

The time series of estimated spring nursery habitat for European salmon stocks were applied as in Friedland et al. (1993). However, the area was constrained to that part of the North Sea and North-East Atlantic Ocean where it could reasonably be expected that post-smolt salmon from the Figgjo and North Esk would exist during the spring months (Figure 8.2.4.1). The area was further constrained by examining 3° C sea surface temperature bands set at 8-10° C in April, May and June, 7-9° C in June, July and August, 6-8° C in August, September and October and 5-7° C in October, November and December.

Significant correlations were found between recapture rates for:

* 1SW and 2SW salmon tagged as smolts in the River Figgjo (r=0.937, P=0.000),
* 1SW and 2SW salmon tagged as smolts in the North Esk (r=0.937, P<0.001)
* 1SW salmon from the River Figgjo and 1SW salmon from the North Esk (r= 0.904, P<0.001)
* 1SW salmon from the River Figgjo and 2SW salmon from the North Esk (r= 0.898, P=0.898)
* 1SW salmon from the North Esk and 2SW salmon from the River Figgjo (r=0.852, P<0.001)
* 2SW salmon from the River Figgjo and 2SW salmon from the North Esk (r=0.869, P<0.001)

Examination of the catch data also showed significant correlations between catches of:

* 1SW salmon and MSW salmon in Norway (r=0.511, P=0.009)
* 1SW and MSW salmon in Scotland (r=0.702, P=0.000)
* MSW salmon in Norway and MSW salmon in Scotland (r=0.701, P=0.000)
* 1SW salmon in Scotland and MSW salmon in Norway (r=0.481, P=0.015)

Catches of 1SW salmon in Scotland were marginally correlated with catches of 1SW salmon in Norway (r=0.393, P=0.052) but there was no correlation between 1SW salmon from Norway and MSW salmon from Scotland (r=0.301, P=0.143). However, further examination of these data is required to investigate the existence of possible common temporal trends in the data, for example in 1SW:MSW ratios, which may affect these analyses.

In both the River Figgjo and North Esk, there were significant, positive correlations between age-specific survival and the area of 8-10° C water during the month of May. However, in November, there were significant but negative correlations with the area of 5-7° C water. The relationships between time series of May and November habitat areas and time series of 1SW survival rate of River Figgjo and North Esk salmon are shown in Figure 8.2.4.2.

These results suggest that survival of both 1SW and 2SW salmon to the River Figgjo and the North Esk may be predictable from measurement of the area of 8-10° C water in the North Sea and North-East Atlantic during the month of May in the year of smolt migration.

The Working Group also explored the relationship between the proportion of salmon returning as MSW fish and the mean weight of the grilse component. Tagging data from the River Laggan (Sweden) were used to analyse this possible relationship in the total numbers of homing fish from respective smolt year classes. Data from the release years 1969 to 1991 were used. In the Swedish tagging data base, tags reported from Swedish coastal waters and rivers are presumed to represent the homing salmon. The mean weights of recaptured grilse (where weights were provided) are negatively correlated with the proportion of the fish returning as MSW fish (r^2 = 0.27, p<0.01) (Figure 8.2.4.3).

8.2.5 Development of catch advice for the NEAC area

The Working Group were unable to provide detailed catch advice for stocks in the NEAC area. However, in view of the apparent decline in the pre-fishery abundance estimates for non-maturing 1SW salmon in both Southern and Northern European stock complexes it is recommended that levels of exploitation on these stock components in mixed stock fisheries are not allowed to increase until more detailed assessments are available which show that this will not have an adverse effect on recruitment.

9. ASSESSMENT ADVICE FOR WEST GREENLAND COMMISSION AREA

9.1 Development of Catch Options for 1995 and Assessment of Risks

9.1.1 Overview

The Working Group was asked to continue with the development and evaluation of methods to advise on catch levels based upon maintaining adequate spawning numbers. The problems of estimating the total allowable catch (TAC) for salmon have been examined by the Working Group in previous years (Anon., 1982, 1984, 1986a, 1988a) and were repeated in the two last Working Group reports (Anon., 1993a, 1994a). Although advances have been made in our understanding of the population dynamics of Atlantic salmon and the exploitation occurring in the fisheries, the concerns about the implications of applying TACs to mixed stock fisheries are still relevant. In principle, reductions in catches in mixed-stock fisheries provided by means of an annually adjusted TAC would reduce mortality on the population as a whole. However, benefits that might accrue to particular stocks would be difficult to demonstrate, in the same way that adverse effects on individual stocks would be difficult to identify.

In 1993, the Working Group considered how the predictive measures of abundance could be used to give annual catch advice (Anon. (1993a); Sections 5.3 and 5.4). The aim of management would be to limit catches to a level that would facilitate achieving overall spawning escapement equivalent to the sum of spawning targets in individual North American and European rivers (when the latter have been defined). In order to achieve the desired level of exploitation for a given level of predicted abundance, a TAC could be fixed or some form of effort limitation introduced.

The advice for any given year is dependent on obtaining a reliable predictor of the abundance of non-maturing 1SW North American stocks prior to the start of the fishery in Greenland. Commercial gill net fisheries in Greenland and Labrador harvest one-sea winter (1SW) salmon about one year before they mature and return to spawn in North American rivers. This component has also been harvested on their return as 2SW salmon in commercial fisheries in Labrador and Québec, angling and native fisheries throughout eastern Canada and angling fisheries in the north-eastern USA. Currently, prediction of the pre-fishery abundance of 1SW salmon destined to return as 2SW fish is difficult.

Biological rationale for catch advice model

The Working Group has previously addressed in some detail the wide range of factors both abiotic and biotic that could influence survival of salmon in the sea (Anon. 1993a, Anon. 1994a). Factors in the freshwater phase may influence subsequent marine survival by varying size and condition of salmon smolts that enter the sea. In the sea, factors at work in coastal areas may affect the survival of emigrating smolts, while other factors may influence survival in the open sea over their entire life history. As can been seen by reference to Section 5.2.4, sea survival in many stocks continues to be at or near record low levels in many of the time series available to the Working Group.

The Working Group briefly reviewed the biological rationale for the catch advice model first used in Anon. (1993a). The hypothesis tested was that the marine habitat available for salmon in the north-west Atlantic at some time prior to the end of their first winter at sea directly controls the numbers of 2SW salmon produced. In this analysis, a relative index of marine habitat thought suitable for salmon (termed thermal habitat) was determined for the months of November, December, January, February, and March by weighting salmon catch rates from experimental fishing and sea surface temperature data. Analysis of variance indicated that pre-fishery abundance was significantly related to thermal habitat in all of these months. The relationship using March habitat was chosen for prediction because it had the best correlation. Also thermal habitat frequently was at a annual minimum in March and may be the most limiting for salmon production.

However, it is recognised that there is no specific proven rationale for what is causing mortality to salmon in the sea and decreasing returns to freshwater. It is unlikely with the current levels of research on salmon life history in the north-west Atlantic that this question will ever be explicitly answered.

9.1.2 Pre-fishery abundance estimates of North American salmon

North American Run-Reconstruction Model

The Working Group has used the North American Run-Reconstruction Model to estimate the fishery area exploitation rates for West Greenland. The data required to estimate exploitation rates are also used to estimate pre-fishery abundance, which serves as the basis of abundance forecasts used in the provision of catch advice. The Working Group noted that it might be possible to extend the time series to include the years 1969-73 and to include grilse and 2SW salmon. The Working Group recommended that the possibility of this being done be pursued.

pre-fishery abundance estimator for year i [N1(i)] represents the non-maturing component of 1SW fish destined to be 2SW returns. It is constructed by summing 2SW returns. in year i+1 [R2(i+1)], 2SW salmon catches in Canada [C2(i+1)], and catches in year i from fisheries on non-maturing 1SW salmon in Canada [C1(i)] and Greenland [G1(i)]. An assumed natural mortality rate [M] of 0.01 per month is used to adjust the back-calculated numbers between the salmon fisheries on the 1SW and 2SW salmon (10 months) and between the fishery on 2SW salmon and returns to the rivers (1 month) as shown below:

$$N1(i) = (R2(i+1) / S1+C2(i+1))/S2 + C1(i) + G1(i)$$
.Eq.9.12.1

where the survival parameters S1 and S2 are defined as exp(-M * 1) and exp(-M * 10), respectively.

This estimated pre-fishery abundance represents the extant population and does not account for the fraction of the population present in a given fishery area. The model does not take into account non-catch fishing mortality in any of the fisheries. This is because rates for non-catch fishing mortality are not available on an annual basis and are not well described for some of the fisheries harvesting potential or actual 2SW salmon. Thus, 1993 catches used in the run-reconstruction model for the West Greenland fishery and Newfoundland fishery were set to zero in order to remain consistent with catches used in other years in both of these areas (see Section 2.3.1).

Estimates of fishery area exploitation rates in West Greenland require all of the data for pre-fishery abundance plus estimates of grilse returns and maturing 1SW catches in SFAs 3-7, 14A in Newfoundland. The latter two data requirements also allow the estimation of a fishery area exploitation rate in Newfoundland. (For additional details on estimation see Rago *et al* (1993b)).

The Working Group updated the databases for these two models. Region-specific estimates of 2SW returns are listed in Table 5.2.2.2. Estimates of 2SW returns in Labrador are derived from estimated 2SW catches in the fishery using a range of assumptions regarding exploitation rates and origin of the catch. For 1993 and 1994 returns, the estimates were further adjusted to account for a 42% reduction in licensed fishing effort in Labrador between 1992 and 1993 and a 13% reduction between 1993 and 1994 (See Section 7.1).

Catches by size class and year are summarised in Table 9.1.2.1. The Newfoundland fishery (SFA 3-13, 14A) was closed in 1992, 1993 and 1994, so no catches are applicable for those years. Derived catches by sea-age are summarised in Table 9.1.2.2. The minimum and maximum values are derived using the methodology and parameters described in Rago *et al* (1993a). The derived estimates of pre-fishery abundance (Table 9.1.2.2) are slightly higher than reported in Anon. (1993a) and reflect the correction of the estimates for the Newfoundland 2SW returns in SFAs 3-11. Previously, assumed proportions of large salmon were used to derive 2SW returns from the numbers of grilse returns. This was changed so that the proportion used is determined each year from fishway counts where available.

Pre-fishery abundance estimates for 1993 were the lowest in the 20 years time series (Table 9.1.2.2 and Figure 9.1.2.1). The 1993 abundance estimates ranged between 99,000 and 201,000 salmon. Results suggest a continuing downward trend in pre-fishery abundance for North American MSW stocks. The Working Group expressed its concern for the continued decline in estimates of pre-fishery abundance.

The implications of the uncertainty in N1 for the derivation of catch advice were addressed using Monte Carlo simulation (Reddin *et al*, 1993). For each year, the approximate distribution of N1 was estimated by assuming that R2, C2 and C1 were uniformly distributed random variables whose ranges are defined in Table 9.1.2.2. The randomly and independently selected values of R2, C1, and C2 were substituted into Eq. 9.1.2-1 to obtain a realisation of N1. The probability density function for N1 was approximated by 200 independent realisations.

The minimum and maximum values of the catches and returns for the 2SW cohort are summarised in Table 9.1.2.2. Estimates for 1993 decreased markedly below the previous year. The low abundance observed in 1978 and 1983-84 were followed by large increases in pre-fishery abundance. However, if the data are divided into sets above and below the 20 year mean, the likelihood of a poor year (i.e. below mean) being followed by a good year (i.e. above the mean) is low, as illustrated in the following table:

Pre-fishery abundance in year i	Pre-fishery abundance in y i+1	
	Poor	Good
Poor	6	2
Good	3	8

These results suggest that salmon abundance tends to persist in "poor" and "good" states for several years. Moreover, the likelihood of reversing from poor to good in a single year appears to be about 10%.

9.1.3 Thermal habitat forecast model for pre-fishery abundance of North American salmon

Overview of thermal habitat

The thermal habitat model presented in Anon (1993a; 1994a) involved the use of regression analysis to predict the pre-fishery abundance of non-maturing 1SW fish prior to the start of the fishery using thermal habitat, as derived by the techniques described by the Working Group (Anon. 1994a), as the independent variable. In this analysis, a relative index of the area suitable for salmon over-wintering was developed by weighting salmon catch rates from experimental fishing and sea surface temperature data from earth observation satellites and ships of opportunity obtained from the Comprehensive Ocean-Atmospheric Data Set (COADS) issued by the National Centre for Atmospheric Research at Boulder, Colorado, USA. The area used to determine available salmon habitat encompasses the north-west Atlantic north of 41° N latitude and west of 29° W longitude and includes the Davis Strait, Labrador Sea, Irminger Sea, and the Grand Bank of Newfoundland (Figure 9.1.3.1).

Thermal habitat for salmon was derived from SST data obtained from the National Center for Atmospheric Research at Boulder, Colorado and consisted of two data sets of monthly mean SSTs on a 2° grid. The first data set labelled "*in situ*" consisted of SST data that extended up to 61° N latitude from 1970-81. It was derived from sea surface temperatures recorded *in situ* by ships of opportunity, buoys, and sea-ice limits (COADS-CAC analysis). The second data set labelled "blended" data extended from 1982-94. The blended data compiled by NOAA (National Ocean & Atmospheric Administration) were derived by blending SSTs from *in situ* measurements by ships of opportunity, buoys, ice cover, with satellite data (Reynolds 1988). The blended data ended as of December 1994 and NOAA has replaced it with weekly SST values on a 1° grid using a new technique of optimally interpolating SSTs from climatology, satellite and ice cover data (Reynolds & Smith 1994; Reynolds et al. 1994). This section reconstructs thermal habitat based on SST from the optimal interpolation analysis (OI data) and compares it with the original thermal habitat data from the blended series.

Revising estimates of thermal habitat

The SSTs from the OI analysis are of higher resolution than the previous blended data; however, the OI analysis uses the same basic data as was used previously in the blended series. The new OI method has been described in detail by Reynolds & Marsico (1993) and Reynolds & Smith (1994). Briefly, the SST data output from earth observation satellites assumes that the data do not contain spatial biases which is an invalid assumption for satellite data as shown by Reynolds (1988). In order to correct for the biases in the satellite derived SST data, *in situ* data is used to provide a preliminary large-scale spatial correction of the satellite retrievals of SSTs. The corrected satellite data are then analysed both weekly and daily on a 1° lat/long spatial grid (Reynolds & Smith 1994). The satellite data used were obtained from the Advanced Very High Resolution Radiometer (AVHRR) on the NOAA polar orbiting satellites. The monthly OI fields were computed by linearly interpolating the weekly fields to produce daily fields and then averaging the appropriate days within a month to produce monthly averages (Reynolds et al. 1994).

Reynolds et al. (1994) discuss the impact of the analysis change using equatorial Pacific time-longitude cross-sections of the monthly blended anomaly and the monthly OI anomaly for the entire period of record. The results show that the two data sets are comparable although some oceanographic features are stronger in the OI analysis than in the blend. In order to verify the difference between the analyses, Reynolds et al. (1994) compared the analyses with independent data. The SST data obtained from satellite imagery is shown to be highly accurate and the new OI analysis was superior to the old blended data series.

Determination of thermal habitat

The index of over-wintering habitat termed thermal habitat has been fully detailed in Anon. (1993a) and Reddin et al. (1993). It was developed by computing a weighted sum of sub-area squares within the region specified in Figure 9.1.3.1. The area used to determine available salmon habitat encompassed the north-west Atlantic north of 41° N latitude and west of 29° W longitude and includes the Davis Strait, Labrador Sea, Irminger Sea, and the Grand Bank of Newfoundland. Weighting factors were derived from mean catch rates obtained from a variety of research vessel surveys in the north-west Atlantic Ocean (Møller Jensen & Lear 1980; Reddin 1985; Reddin & Shearer 1987; Reddin & Short 1991). Catch rates (CPUE) were expressed as numbers of salmon caught divided by the product of net length in nautical miles and the length of time the nets were in the water:

CPUE = number of salmon caught / (length of nets * hours fished) (Eq. 9.1.3-1)

Average sea surface temperatures (SST) for each set were also recorded. Catch rate data were analysed as a function of SST standardised to a normal distribution and categorising SSTs (°C) into the following groups 1 to j: 0.5-1.5°, 1.5-2.5°, 2.5-3.5°, 3.5-4.5°, 4.5-5.5°, 5.5-6.5°, 6.5-7.5°, 7.5-8.5°, 8.5-9.5°, 9.5-11.5°, 11.5-13.5° (Figure 9.1.3.2) (Reddin et al. 1993).

The overall area was then summed from the areas of the individual 2° squares for the blended analysis and 1° squares for the OI analysis as described in Friedland and

Reddin (1993). A relative index of the area suitable for salmon was developed by weighting the area at each temperature group by the catch rate for the same temperature group from the research vessels as follows:

$$T = \Sigma\ C * A \qquad \text{(Eq. 9.1.3-2)}$$

where T is thermal habitat, and A is area of each 1° square from 1 to j SST categories. The area of each square was determined as the product of the cosine of ° latitude of the mid-point of each square and 111.1 km. Thermal habitat values for the months of March and the sum of January to March are shown in Table 9.1.3.1 for the north-west Atlantic Ocean, 1970-95.

There are several possible factors that could cause differences between the OI and blended SST data: 1° squares vs 2° squares; weekly data vs monthly; accuracy of OI vs blended analyses. The impact of these factors was examined collectively by comparing the new thermal habitat derived from the OI analysis to the thermal habitat derived using the blended data (Figure 9.1.3.3, Table 9.1.3.1). The results indicate that the OI provides a thermal habitat measure that is consistently less than the blended data did. The thermal habitat from the OI analysis is on average 6% lower during March, 1982-94. However, the trend in the two data sets are the same ($r = +0.85$, $df = 11$, $P<0.01$).

Thermal habitat data were available for all months of the year from 1974 to March of 1995 (Table 9.1.3.2). Other sets of thermal habitat data were formed by summing together thermal habitat for a variety of months. These data from the OI analysis were used to determine the best forecaster for pre-fishery abundance. In order to examine possible predictive relationships several hypotheses were formed:

a) pre-fishery abundance related to grilse abundance or grilse size;

b) pre-fishery abundance related to thermal habitat during the winter months and SST during summer to fall that could influence post-smolt growth and hence survival; and,

c) pre-fishery abundance related to thermal habitat during the winter months (January to March) or some combination of these determined as the sum of thermal habitat.

Due to a lack of unbiased data on grilse abundance and grilse size as a result of the various fisheries closures and reductions in effort removed (see Section 7.1), it proved impossible to test hypotheses (a) related to these factors. Other relationships proved to be considerably less significant than relationships with winter thermal habitat alone, and so winter thermal habitat was further examined. The Working Group examined the possibility of using the summed thermal habitat for January, February, and March (winter) which would have the advantage of broadening the basis for the predictive relationship and would be less subject to small variations in the monthly habitat data. All of the relationships for winter months proved significant; however, the best proved to be the sum of thermal habitat in January, February, and March ($r = 0.75$, $F = 23.1$, $P = 0.0001$, $n = 20$). In the original analysis in Anon. (1993a, 1994a), March thermal habitat was used based on its higher correlation using the extant data available at that time. In the present analysis, it had a slightly lower correlation ($r = 0.73$, $F = 21.0$, $P = 0.0001$, $n = 20$) than did summing the winter habitat values. In response to the strong recommendation from ACFM and due to its better fit with the pre-fishery abundance data the thermal habitat model with the sum of January, February, and March (winter) was carried forward.

9.1.4 Thermal habitat forecast model for pre-fishery abundance of North American salmon

Two periods of decline in the available habitat are identified (1980 to 1984 and 1988 to 1995) in both the March and winter thermal habitat data (Table 9.1.3.1 and Figure 9.1.4.1). Available habitat was slightly lower in 1995 than in 1994 in both the March and winter data. In the March and winter data, the 1995 value is the third lowest in the time series.

Figure 9.1.4.2 shows the relationship between pre-fishery abundance and winter thermal habitat. The predicted values for pre-fishery abundance by the winter thermal habitat method and the observed abundance for 1974-1993 are shown. An unbiased prediction of pre-fishery abundance and its residuals was made by a leave-one-out procedure that refit the regression in this case 20 times The predicted values from this procedure are also shown in Figure 9.1.4.3. The predicted values are shown to fit the observed data quite well except during the period of low abundance in 1978 and in the late 1980s and 90s when abundance was low. The forecasted estimate of pre-fishery abundance for 1995 using this model is about 242,000 at the 50% probability level (Table 9.1.4.1).

Concern was expressed by the Working Group that all of the residual values since 1988 have been negative (Figures 9.1.4.3 & 9.1.4.4 and Table 9.1.3.1), indicating that the actual values are considerably lower than those predicted. If this trend continues in 1995 then the actual pre-fishery abundance could be lower than the forecasted value of 242,000. A problem with the predictive relationship between pre-fishery abundance and winter thermal habitat is the very low 1978 value and hence high residual (Figure 9.1.4.3). Without this value the relationship between pre-fishery abundance and winter thermal habitat is considerably better ($r = 0.85$, $P = 0.0001$) as are the predicted values. However, the Working Group felt that there was insufficient biological justification for leaving the pre-fishery abundance for 1978 out of the relationship.

Stochastic Analyses

Although the exact error bounds for the estimates of N1(i) are unknown, minimum and maximum values of component catch and return estimates have been estimated. Monte Carlo methods, implemented in the software package Risk (Pallisade, 1992), were used to simulate the probability density function of N1(i).

Simulated values of N1(i) were also used to evaluate the distribution of mean values for the regression models between pre-fishery abundance and winter thermal habitat.

To estimate the composite error distribution of the 200 realisations, it was assumed that the forecast was distributed normally, with a mean equal to the forecast and variance equal to the mean square error of the estimate. The composite sampling distribution for the forecast was estimated as the sum of the underlying distributions for each stochastic realisation j:

$$F_{C}(N1_{FOR}(1995), s_{C}^{2}) = S_{j=1,200}\ F_j(N1_{FOR}(1995)_j, s_j^{2})/200 \qquad \text{(Eq. 9.1.4-3)}$$

where F( ) is the normal probability density function. Integration of the normal distributions was approximated using the trapezoidal rule (Press *et al.* 1986).

The sampling distribution of the composite stochastic forecast, i.e. $F_{C}(N1_{FOR}(1995), s_{C}^{2})$ was used to compute forecast values in 5% percentile steps from 25% to 75%. The 5% percentiles are used in the computation of alternative quotas under varying levels of risk where risk refers to the probability that the spawning target $R2_T$ will not be met (Appendix 5).

The stochastic forecasts permitted the estimation of the cumulative distribution function for each forecast (Table 9.1.4.1). These estimates can be used to quantify the relative probabilities of attaining spawning targets for the stock under different allocation schemes. Managers may also use this information to determine the relative risks borne by the stock (i.e. meeting spawning targets) versus the fishery (e.g. reduced short-term catches).

9.1.5 Advice on the Selection of Risk Levels

The quota agreement for the West Greenland commission is based on a relationship between the distribution of sea surface temperature and salmon abundance (Reddin et al. 1993). The structure of the scientific advice allows managers to select an assigned risk associated with the likelihood of achieving the management objective of attaining target spawning escapement in natal river systems. ACFM, in its advice to NASCO in 1994 (Anon. In prep), pointed out that the 50% risk level only provides for the attainment of target spawning escapement in half of the rivers, or in all the rivers half of the time. Thus, it would be likely to result in the long-term decline of some stocks. They recommended that some value less than the 50% level be adopted; however, they provided no guidance for the selection of that level or what criteria might be considered in doing so.

Populations have been studied through the use of age-based matrix models that utilise projections of even-aged cohorts sharing common fertility and survival risk vectors over time (Leslie 1945). These models are relatively inflexible in their formulation and are unable to accommodate complex life history patterns. Stage-based models represent a generalisation of age-based models by recognising developmental stages organised into cohorts or classes which share the same demographic properties (Lefkovitch 1965, Groenendael et al. 1988, Caswell 1989). Population declines, especially a decline through some economically or ecologically important threshold, are particularly important to resource managers and scientists where they relate to loss of population productivity or if they pose a threat of extinction (Crouse et al. 1987, Ferson et al. 1989, Burgman and Gerard 1990, Ferson and Burgman 1990). When life history patterns include complex density dependence and externally driven stochastic effects, it is very difficult to make analytical assessment of population level risks. However, modelling simulation does provide a way of developing risk estimators for populations with varying demographic characteristics.

The Working Group reviewed a stage-based projection model for North American 2SW salmon stocks and considered how the stochastic projections from this model might be used to guide the assignment of risk associated with various management policies in the West Greenland Commission.

Model Formulation

The North American 2SW stock complex was simulated in the projection model software RAMAS/Stage (Ferson et al. 1987). The stage-based model can be represented by a network diagram (Figure 9.1.5.1) which is governed by a series of stage transition formulae (Table 9.1.5.1). Stage transitions rely on transition probabilities or driver functions which are drawn from random normal distributions parameterised with means and variances intended to recreate the properties of the actual stock complex (Table 9.1.5.2). For example, the model has been parameterised to produce patterns of post-smolt survival and smolt-age distribution that conform to patterns observed for North American 2SW stocks (Anon. 1994a).

The deposition of eggs by 2SW escapement, which governs the production of fry, is a density dependent relationship (Figure 9.1.5.2). The curve is formed by a Ricker function, the shape of which was assumed, from zero spawners to the spawning target and suggests density dependent effects at high stock densities. Above the target, the relationship is constant, which suggests constant recruitment over the target. This is of no consequence for the evaluation of contemporary harvest policy; however, simulations examining historical fishing would be affected by this assumption. Freshwater stages include fry and age 0 through age 4 parr. Age 1 through 3 parr may mature into smolts at the end of a year, die, or stay in freshwater to enter the next oldest parr age category. Age 4 parr either die or transform into smolts. Transitions to the next oldest stage or to smolts are governed by age specific driver functions (Table 9.1.5.2). Smolt production is then translated into number of 1SW salmon by the post-smolt survival driver (pssur) which includes an auto-correlated property. An obvious deficiency of the model is the absence of sexual maturation at 1SW. However, until the properties of that component of the stock are better understood, it will not be possible to add this to the model. In addition, the Working Group identified the need to refine estimates of mortality rates and smoltification processes in freshwater to closer reflect the stock complex and to test the sensitivity of the model.

Simulations were based on 1000 realisations over a time horizon of 100 years. A series of management scenarios were explored by abundance 'adjustments' to simulate the effect of baseline present management policy, historical patterns of fishing mortality, and four levels of more conservative management policy than is presently in place. These adjustments were achieved with a simple multiplier added to the 1SW (one sea) stage transition formula (Table 9.1.5.1). Thus, the baseline model used an adjustment multiplier of 1 (i.e. the abundance of 1SW fish was carried to the next stage without adjustment); historical fishing used a multiplier of 0.6 (i.e. in all years, 40% of the stock was removed by fishing); and adjusting the stock to progressively higher levels (HS) used an adjustment multiplier of greater than 1, which had the same effect as managers using lower levels of management risk in setting the quota at West Greenland.

Quasi-extinction rates offer a methodology to evaluate the consequences of the various management scenarios. Quasi-extinction rates are a simple risk assessment methodology whereby the probability of a population falling below a designated critical threshold is characterised. These probabilities can be developed in two ways, either as 'interval' or 'terminal' rates. 'Interval' rates represent the probability of occurrence of a minimum population size over the entire simulation period. These rates are more likely to capture episodes of low abundance often associated with auto-correlated time series, as is the case with salmon survival. 'Terminal' rates are the probability of occurrence of particular population sizes at the end of the simulation periods. If the population tends to decrease over time, 'interval' rates will be similar to 'terminal' rates.

Quasi-Extinction Rates for the North American Stock Complex and Management Advice

Both 'interval' and 'terminal' quasi-extinction rates for escapement levels reveal a striking contrast between the risks of not achieving escapement goals for present management and past fishing policy. 'Interval' rates show that with a constant rate of fishing on the stock, minimum escapement can frequently fall below 75,000 salmon (Figure 9.1.5.3). Management policy based on spawning escapement target tends to keep escapement occurrences well above 100,000, and there is progressively less risk of lower escapement with higher assumed stock size (HS 5% to 30%). Higher stock sizes are not directly comparable to currently defined risk probabilities levels; however, they can be associated with logical ranges of these risks. Terminal quasi-extinction rates are less conservative since they are only tallying escapement at the end of the simulation period; nevertheless the same general pattern is evident (Figure 9.1.5.4).

Although the family of quasi-extinction rate curves were themselves informative, additional features were extracted from these data to compare the effect of the different stock size adjustments. 'Interval' rates formed symmetric ogives, so the escapement level at the 50% probability gave a trend of increased escapement with greater stock size 'adjustment' multipliers (Figure 9.1.5.5). This indicates there is a reduced risk of the escapement being below target with progressively greater 'adjustment' multipliers .

'Terminal' rate curves were somewhat irregular, so a point feature of the curves could not be identified; a different approach was therefore employed with these curves. The integrated area under each curve was calculated and taken to represent the cumulative probability of escapement occurrences below target. The integrated areas for different stock size adjustments formed a curve of progressively lower probability with great stock size adjustment (Figure 9.1.5.6). The curve formed by these points suggests the most rapid accumulation of benefit, i.e. lower risk of missing escapement target, is realised with a 10% adjustment of stock size. In a practical sense, managers may use this advice to select a risk level associated with a pre-fishery abundance 10% lower than the abundance at the 50% risk level.

The Working Group recommended that a sensitivity analysis be conducted to assess the sensitivity of the stage based model to the input parameters.

Because these results are based on an equilibrium model parameterised to mean effects, they may be optimistic during conditions of low stock size. The present condition of North American stocks suggests that escapement targets are not being met in many regions; thus it is critical for some individual rivers to receive as much egg deposition as possible. The Working Group encourages the selection of projected abundance levels associated with risk averse probability levels for the determination of quota levels

9.1.6 Development of catch options for 1995

Development of Catch Advice

To prevent recruitment over-fishing, the goal in Atlantic salmon management is to ensure adequate numbers of spawners in each spawning river. In mixed stock fisheries, this is not possible owing to varying migration patterns and exploitation rates experienced by individual stocks. Nonetheless, it is possible to define a composite spawning target for the North American stock complex by summing the spawning targets of Salmon Fishing Areas in Canada and river basins within the USA. Details on the methodology to estimate and update the spawning targets are provided in Anon. (1993b) and in Sections 5.2.1 and 9.2 of this report.

The procedure used to compute an allowable harvest is unchanged from the previous assessment (Anon. 1994a) and is shown in Appendix 5.

The assessment models used for the provision of catch advice are based almost entirely upon data for North American stocks. While it is believed that European stocks are generally less vulnerable to the West Greenland fishery than North American stocks, there has been evidence of a more rapid decline in these stocks, in the West Greenland area at least, than in the North American stock (Anon., 1993a). The Working Group therefore emphasised the importance of continued development of similar assessment methods for the stocks in the North-East Atlantic area.

Catch Advice for 1995

The fishery allocation for West Greenland is for 1SW fisheries in 1995, whereas the allocation for North America can be harvested in 1SW fisheries in 1995 and/or in 2SW fisheries in 1996. To achieve the spawning management goal, a pool of fish must be set aside prior to fishery allocation in order to meet spawning targets and allow for natural mortality in the intervening months between the fishery and spawning migration. The Working Group identified 186,486 fish as the spawning target for the North American stock complex (Table 5.2.1.1). Thus, 208,170 pre-fishery abundance fish must be reserved (186,486 / exp*(-.01*11)) to ensure achievement of the target after natural mortality.

By using the probability density function of the pre-fishery abundance, the probability of the true stock abundance being greater or lower than the value selected can be estimated. This probability level also provides a measure of the probability of reaching escapement targets assuming fishery allocations are taken without error. The mean estimate of the forecast represents a reference point at which there is a 50% chance that the true abundance is lower than required to achieve the spawning target. Likewise, the forecast value at the 25th percentile (the value with a 25% chance that the abundance is lower) and the forecast value at the 75th percentile (the value with a 75% chance that the abundance is lower) characterise the range of decision with lower and higher risks, respectively.

Quota computation (Eq. 5 in Appendix 5) for the 1995 fishery requires an estimate of pre-fishery abundance [N1], stock composition by continent [PropNA], mean weights of North American and European 1SW salmon [WT1SWNA and WT1SWE, respectively], and a correction factor for the expected sea age composition of the total landings [ACF]. Results of the exponential smoothing model forecasts first used in the 1993 assessment (Anon. 1993a), with approximate 50% confidence limits, are summarised below.

Parameter	Forecast	Minus 1SE	Plus 1SE
PropNA	0.540	0.477	0.603
WT1SWNA	2.525	2.406	2.643
WT1SWE	2.660	2.510	2.810
ACF	1.121	1.070	1.172

The Working Group continued to use the 1993 forecasts because there are no biological samples for 1993 or 1994 with which to update the parameters. The Working Group emphasises that these parameters have changed in the past, and thus should be updated with new data periodically to ensure the greatest possible accuracy in the quota calculation.

Greenland quota levels for the forecast over a range of pre-fishery abundance values between interquartile limits of each probability density function are presented in Table 9.1.6.1. For the point estimate level (i.e. 50% level) and the stochastic regression estimate using N1, the quota options ranged from 0 to 192 t, depending on the proportion allocated to West Greenland (Fna). For the Fna level of 0.4 used in recent management measures for the West Greenland Commission, the value is 77 t.

If the guidance on risk selection methods proposed in Section 9.1.5 were adopted, a 10% decrement of the pre-fishery abundance level [242,000-(242,000 * .1) = 217,800] would be associated with a risk level between 40 and 45% (Table 9.1.4.1), and thus yield a quota between 6 and 45 t. This catch advice is predicated on allocation of the predicted abundance of salmon and provides no guidance on salmon availability or fishing patterns.

The 50% risk level is intended to produce spawning escapement in North America that will meet the target level for all rivers combined. Even if this overall target is achieved, it is likely that some stocks will fail to meet their individual target spawner requirements while others will exceed target levels. This may result from random variation between years or from systematic differences in the patterns of exploitation on fish from different rivers or regions. In the latter case, adoption of a 50% risk approach may result in some stocks failing to meet target levels over an extended period. This would be likely to result in the long-term decline in those stocks. The Working Group therefore felt that in the long term, catch advice should be based upon the stocks or stock complexes that are most vulnerable to the fishery. Vulnerability is largely a function of stock productivity and availability to the fishery.

It is evident to the Working Group from both the indicators of stock status and the extremely low quota levels computed under both previously used and proposed risk levels, that the North American stock complex is in a tenuous condition. We are observing record low stock levels despite nearly complete closures of mixed and single stock fisheries, a continuing trend of below target spawning escapement for 2SW salmon, and some of the lowest marine survival rates for monitored stocks. The incremental advantage associated with each additional spawner in under-seeded river systems makes a strong case for recommending a conservative management strategy.

9.2 Review of Target Spawning Level in USA Rivers

9.2.1 Rationale for spawning targets in Canada and the USA

The standard 240 eggs.100m^{-2} is composed of two parts; the numerator which is the eggs, and the denominator which is a measure of habitat area. The numerator defines a level of production for Atlantic salmon while the denominator is a scaling factor for transportability to other river systems. In Canada, both components have their origin in studies on the Pollett River (SFA 23) by Elson (1975).

In a first experiment on the Pollett River, a section which was devoid of salmon was stocked with fry at densities ranging from 20 to 220 fry .100 yd^{-2}. Under conditions of predator control, it was concluded that the maximum smolt production was 5 smolts.100 yd^{-2} and that this level could be achieved at fry densities of 35-40 fry.100 yd^{-2}. In the second experiment, adult salmon were allowed to enter the same section of the Pollett River and to spawn naturally. The data from the experiment suggested that the maximum smolt production was 5 to 6 smolts.100 yd^{-2}, similar to the stocking experiment. The optimal egg depositions required to produce this number of smolts was in the order of 240 to 290 eggs.100m^{-2} . The area of habitat referred to in the Pollett River study was the total bottom area of stream accessible to salmon, and only a small proportion of the areà was of lower quality rearing habitat.
Symons (1979) indicated that the egg to smolt relationship is compensatory and asymptotic and that maximum smolt production depended upon the average smolt age. For stocks producing mainly 2-year old smolts, an average production of 5 smolts.100m^{-2} could be achieved at egg deposition levels of 200 eggs.100m^{-2} .

Where specific stock-recruitment data were not available, 240 eggs.100m^{-2} of fluvial habitat was therefore adopted as the standard egg deposition target for eastern Canadian rivers.

In the absence of alternative egg deposition targets for USA rivers, the Canadian value has been used. Derivation of the optimal spawning numbers of 2SW salmon in USA rivers is based upon the work of Elson (1975), and historical observations of the populations, particularly during periods prior to the initiation of mixed-stock fisheries. The sea-age composition of such stocks reflects some balance of evolutionary selective factors, particularly mortality rates in the freshwater and marine environments. Beyond those considerations, 2SW salmon returns reflect the intention to preserve or restore historical fishing opportunities within rivers.

9.2.2 Estimated USA spawner requirements

Composite estimates for 2SW spawning targets were developed for salmon rivers in the USA based upon the number of accessible juvenile salmon habitat units, a 50-50 sex ratio, a fecundity of 7,200 eggs/female, and an assumption that all eggs are provided by maiden 2SW salmon. Summary estimates and references by geographical region in New England are provided in Table 9.2.2.1. Estimates for existing juvenile salmon habitat are based upon available information, while estimates of potential salmon habitat assume that spawners would have access to measured habitat at some time in the future. Estimates of habitat for most of the rivers in the State of Maine are considered minimums because much of the existing information is based upon incomplete and/or outdated information which was collected 30-40 years ago (e.g., most rivers have fewer dams today, water quality has been markedly improved, and the technology available today allows more complete assessment of available habitat).

Approximately 57% of the existing USA Atlantic salmon habitat is located in the rivers of Maine, while 33% is located within the Connecticut River drainage. The Merrimack River in New Hampshire accounts for about 9% of the USA total and the Pawcatuck River in Rhode Island contains the remaining 1%. The total estimated number of 2SW spawners for the currently accessible juvenile salmon habitat in the rivers of New England is 29,199. Estimates of required spawners by geographical region are: 16,506 for Maine rivers, 9,727 for the Connecticut River, 2,599 for the Merrimack River and 367 for the Pawcatuck River (Table 9.2.2.1).

If all of the measured habitat were utilised a minimum of 20,206 additional 2SW spawners would be required.

9.2.3 Current potential for USA rivers to achieve spawning targets

Expectations of 2SW adult returns to USA rivers in 1996 were estimated from stocking records (smolt releases in 1994, age 1 parr in 1993, age 0+ parr and fry releases in 1992) and the estimated number of wild female spawners in Maine rivers in 1991. Individual estimates were made for the Connecticut River, Pawcatuck River, Merrimack River, Penobscot River, and all other Maine rivers combined. Input data used for each geographical area were as follows (values are in thousands):

	Connecticut	Pawcatuck	Merrimack	Penobscot	Other Maine
1991 female spawners	0	0	0	0.415	0.500
1992 fry releases	2009	0	1118	925	253
1992 age 0+ parr	313.9	70.8	0	278.2	106.7
1993 age 1+ parr	28.0	4.0	0	9.6	0
1994 smolts	375.1	2.0	85.0	567.6	80.6
% 2SW (from stocking)	99%	100%	92%	74%	74%
% 2SW (from natural reproduction				81%	81%

In addition, for Maine wild spawners, a fecundity of 7,200 eggs/female and egg to smolt survival of 1.25% was assumed. For stocked fish, fry to smolt survival was estimated at 5%, while parr to smolt survival was estimated at 10%. Smolt to adult survival was estimated to range from 1-3% for stocked smolts, based on observed returns in the presence of fisheries (Figure 5.2.4.3), and 3-5% for wild smolts (Meister, 1962). These estimates were based upon historical information from Maine salmon rivers and numerous studies conducted in New England and similar rivers in Canada. Smolt survival estimates assume no mixed stock fisheries are taking place and that marine survival returns to the levels which were observed in the 1970's. Estimated total returns were adjusted to reflect the average 2SW salmon component observed during the past 5 years in the rivers assessed.

Using the parameters given above and based upon the releases expected to contribute to the 1996 2SW returns and estimated wild smolt production, the total potential 2SW salmon returns to USA rivers could range from 18,264 to 42,853. Estimates for the four geographical areas were as follows:

Potential Connecticut River Adult Returns: Based upon recent stocking levels and the assumptions listed above, potential 2SW salmon returns to the Connecticut River ranged from 7,246 - 17,026. Considering the increasing numbers of salmon being stocked into the Connecticut River in recent years, this system has the potential to achieve its 9,727 target spawners.

Potential Pawcatuck River Adult Returns: Potential adult returns to the Pawcatuck River varied from 138 - 257. Although this system does not appear to have the potential to reach target spawner requirements of 367 at this time, the deficit of 100-200 2SW salmon accounts for less than 1% of the USA total.

Potential Merrimack River Adult returns: Estimated 2SW salmon returns to the Merrimack River ranged from 2,325 - 4,917, indicating that this system would have a high probability of reaching its target spawner requirement of 2,599 salmon.

Potential Penobscot River Adult Returns: Estimated 2SW salmon returns to the Penobscot River ranged from 908 - 1,513 from natural reproduction and 5,557 - 14,862 from releases of hatchery-reared stocks. The combined total of 6,465 - 16,375 2SW returns indicates that the Penobscot River has a high probability of achieving its target spawner requirement of 6,838.

Potential Returns To Other Maine Rivers: For all other Maine rivers combined, estimated 2SW returns ranged from 1,094 - 1,823 from natural reproduction and 996 - 2,455 from stocked fish, a total of 2090 - 4278 fish. Thus these rivers do not appear likely to achieve the target spawning requirement of 9668 fish in 1996. Most of the deficit is located within the following four rivers: Aroostook (tributary to the Saint John), St. Croix (border between Maine - New Brunswick), Union (central Maine area), and the Saco River (southern Maine). Since 1991, the production of hatchery stocks in Maine has gradually been converted from a single stock, smolt-production emphasis (e.g., Penobscot-origin stock) to the production of multiple (river-specific) stocks with increased emphasis upon the production of fed fry. Six river-specific stocks are now in production in Maine and that number is expected to increase to ten in a few years. Additionally, increasing production is being realised from several private facilities (e.g. Aroostook River Salmon Club hatchery, Pleasant River Salmon Club hatchery, Saco River Salmon Club Hatchery), and the State of Maine has initiated discussions with the Maine aquaculture industry to supply additional stocks for restoration purposes. The only major USA river which is scheduled for restoration and is without an enhancement program (and no short-term expectations that one will be initiated) is the Union River. With a target 2SW spawning requirement of 557 salmon this system accounts for about 2% of the target spawner requirements for USA rivers.

The Working Group noted that this study highlighted the growing importance of restoration programmes in many areas of the North Atlantic and recommended that ANACAT consider this as a special theme session.
In summary, spawner targets for all areas under salmon restoration programs in the USA appear reasonable. For those areas of Maine not currently receiving adequate spawning escapement, the potential deficit in 1996 represents 18-26% of the USA 2SW spawner requirements and 3-4% of the total requirement for North America. Although there is a short-term deficit for these rivers, these targets are considered to be achievable in the future. If excess 2SW spawners were achieved in the rivers currently being enhanced, then restoration programs could be initiated and expanded in other Maine rivers where there are spawner deficits.

10. SIGNIFICANT RESEARCH DEVELOPMENTS

10.1 Salmon Ranching

Since 1987, a research programme has been on-going in Iceland to explore the possibilities of using selective breeding to increase performance and profitability of salmon ranching. Results show that there is significant variation in return rates between salmon stocks and even more variation between families within stocks. It was concluded that profitability of ranching could be improved by increasing return rates and body weight at return. Subsequently a breeding plan for sea ranching has been established in Iceland.

These results also have implications for the management of wild salmon because they suggest that there could be genetically based differences in survival rates between stocks.

10.2 Post-smolt Growth and Maturation

The marine survival and sea-age of maturation for two hatchery dependent stocks of Atlantic salmon were compared in respect to differences in post-smolt growth by examination of circuli spacing patterns. The two stocks, the Penobscot and Connecticut, are located at the southern extent of the range of Atlantic salmon in North America. Return rates for 1SW and 2SW salmon were found to be significantly higher in the Penobscot stock. In addition, the fraction of the smolt year class or cohort that matured as 1SW fish was also higher for the Penobscot stock. Image processing techniques were used to extract inter-circuli distances from scales of 2,301 2SW fish. Circuli spacing data were expressed as seasonal growth indices for the spring period, when post-smolts first enter the ocean; the summer period, when growth appears maximal; and the winter period, when growth appears to be at a minimum.

Circuli spacings of the Penobscot salmon were wider during the summer season than for the Connecticut salmon of the same smolt year (Figure 10.2.1). The scales from Penobscot and Connecticut returns had similar freshwater zone lengths, circuli spacing indices in the spring and winter, and a correlated pattern of annual variability between winter growth indices. However, these scales had significantly different summer growth indices and post-smolt growth zone length. The systematic differences in growth, survival, and maturation between these two stocks may be related to their post-smolt migrations suggesting that post-smolt growth may play a significant role in deciding the age-at-maturity and survival patterns of Atlantic salmon.

10.3 Forage Base of Atlantic Salmon in North America and Europe

The relationship between the distribution of sea surface temperature and the abundance of 2 SW salmon seems to be statistically robust although the underlying biological causes remain unknown (Friedland et al. 1993). The transition to marine feeding is recognised as important to post-smolt survival and may contribute to the overall survival of a smolt cohort and thus contribute to the variability in production of the 1 SW and 2SW age components of salmon stocks (Mills 1989). An investigation of the most important prey items may therefore provide a valuable tool to help in understanding how the sea surface temperature affects salmon stocks.

Time series of the abundance of some relevant forage species such as sandeel and capelin were collated for the National Marine Fisheries Service (NMFS) Northeast region, the Scotia Fundy region and the North Sea and Shetland Island area (corresponding respectively to NAFO areas 5 and 6; NAFO area 4; ICES Divisions IVb and IVa for sandeel and NAFO 3KL for capelin). The data were derived from NMFS bottom trawl surveys and VPA assessments made by the ICES Industrial Fisheries Working Group, and a single index of abundance was derived using a multiplicative analysis to standardise individual input components for the 1975 - 92 year classes.

Because several major regions and prey items are missing, this first review is incomplete. It is recommended that it should be completed by including other possible regions and prey items to develop a model describing the relationship and importance of prey to salmon abundance. Such models should, however, consider the predictive models of annual migration and distribution of Atlantic salmon stock complexes already under development.

11. COMPILATION OF TAG RELEASE AND FINCLIP DATA FOR 1994

Data on releases of tagged and finclipped fish in 1994 were provided by the Working Group and will be compiled as a separate report. In excess of 1.64 million CWTs and 0.46 million external tags were applied to Atlantic salmon released in 1994 (Table 11.1). In addition, 2.33 million salmon were marked with finclips alone. Thus more than 4.24 million marked fish were released, 4.05 million of which were hatchery reared. This compares with a total of 3.62 million marked fish released in 1993 and 4.49 million in 1992.

12. JOINT MEETING OF THE WORKING GROUP ON NORTH ATLANTIC SALMON AND THE BALTIC SALMON AND TROUT ASSESSMENT WORKING GROUP.

The Working Group participated in a joint meeting with the Baltic Salmon and Trout Assessment Working Group. A full report of this meeting is appended at Appendix 4. The Working Group fully endorsed the conclusions of the meeting, which are listed at the end of the report. They considered that there would be clear disadvantages (and few advantages) to merging the groups. However, they recommended that efforts should be made to improve communications between the groups in the ways proposed by the meeting.

13. RECOMMENDATIONS

13.1 Fisheries

1. It is evident to the Working Group from both the indicators of stock status and the extremely low quota levels computed under both previously used and proposed risk levels, that the North American stock complex is in a tenuous condition. We are observing record low stock levels despite nearly complete closures of mixed and single stock fisheries, a continuing trend of below target spawning escapement for 2SW salmon, and some of the lowest marine survival rates for monitored stocks. The incremental advantage associated with each additional spawner in under-seeded river systems makes a strong case for recommending a conservative management strategy. (Section 9.1.6)

2. In view of the apparent decline in the pre-fishery abundance estimates for non-maturing 1SW salmon in both Southern and Northern European stock complexes, the Working Group recommends that levels of exploitation on these stock components in mixed stock fisheries are not allowed to increase until more detailed assessments are available which show that this will not have an adverse effect on recruitment.

13.2 Meetings

1. The Working Group recommends that it should meet in 1996 to address questions including those posed by NASCO to ICES. The length of the meeting will have to depend on the questions asked, but if it is to be reduced to less than 10 days, the work-load on the Working Group will have to be reduced. In view of the fact that sea surface temperature data required to provide catch advice for West Greenland is not

expected to be available until 8 April 1996, the group should meet as soon as possible after that date.

2. The Working Group noted the growing importance of restoration programmes in many areas of the North Atlantic and recommended that ANACAT consider this as a special theme session. (Section 9.2.3)

3. The Working Group endorsed the conclusions of the joint meeting with the Baltic Salmon and Trout Assessment Working Group (Appendix 4). They considered that there would be clear disadvantages (and few advantages) to merging the groups. However, they recommended that efforts should be made to improve communications between the groups in the ways proposed by the meeting. (Section 12)

13.3 Data Deficiencies and Research Needs

1. The Working Group supports the continuation of the research fishing programme in the Faroes area and recognises that the results from the project will improve the possibility of developing reliable assessment models in the North-East Atlantic. (Section 4.1.1)

2. Historical scale data from the Faroes fishery should be analysed to assess geographical and temporal variation in smolt age composition of wild salmon which may reflect differences in the stock composition of catches. The results should be compared with historical data on tag recoveries in the Faroese fishery area, to determine whether stock composition estimates by both approaches concur. (Section 4.1.4)

3. The composition by country of origin of national salmon catches in the NEAC area should be determined from best available data for the fours years 1991-94 combined, as a basis for future comparison. (Section 4.1.5)
4. Preliminary spawning targets should be established for all rivers in the North-East Atlantic area as soon as possible. (It is recognised that this may take at least five years in some countries.) (Section 8.2.2)

5. Work should be carried out to refine the estimates of pre-fishery abundance for the North-East Atlantic stocks and to analyse the variability of the estimates. Where possible, separate data sets should be provided for different parts of each country and fishing effort data should examined to improve estimates of changes in exploitation rates. (Section 8.2.3)

6. Further efforts should be made to refine the North American spawning target estimates. Improvements are needed in the areas of the estimation of suitable habitat, the appropriateness of the habitat specific egg targets, and in the determination of the desired sea-age composition of spawners. (Section 5.2.1)

7. The results of monitoring of smolt production and survival from numerous rivers have been useful to the Working Group in the determination of appropriate spawner targets and in investigating and explaining the marine phase of the population dynamics. There are however some areas for which smolt production estimates are not available (e.g. Labrador) and, for areas where there are estimates, they are usually for small rivers or hatchery stocks. It would be useful to expand the enumeration of smolts to other areas and larger rivers. (Section 5.2)

8. The relationship between air temperature at the time of smolt migration and their subsequent survival from the Conne River was presented at this meeting. Further research into mechanisms accounting for the relationship between environmental and biological characteristics would be useful. (Section 5.2.4)

9. The mean weights, sea ages, and proportion of the fish originating from North America and Europe are essential parameters used by the Working Group to provide catch advice for the West Greenland fishery. As these parameters are known to vary over time (Anon., 1993a) and the latest sampling dates back to 1992, the Working Group strongly recommends that a sampling programme is initiated, as outlined in Anon., 1994a. (Section 6.3, 9.1)

10. A sensitivity analysis should be conducted to assess the sensitivity of the stage-based risk analysis model to the input parameters. (Section 9.1.5)

11. The review of forage species should be completed by including other possible regions and prey items to develop a model describing the relationship and importance of prey to salmon abundance. Such models should, however, consider the predictive models of annual migration and distribution of Atlantic salmon stock complexes already under development. (Section 10.3)

Table 2.1.1 Nominal catch of SALMON by country (in tonnes round fresh weight), 1960-1994. (1994 provisional figures).

Year	Canada (1)	Den.	Faroes	Finland	France	East Grld.	West reenlan (2)	Iceland	Ireland (3, 4)	Norway (5)	Russia	Spain (6)	St. P. & M.	Sweden (West)	UK (E & W)	UK N.Ireland (4,7)	UK (Scotland)	USA	Other (8)	Total Reported Catch	Unreported catches NASCO Areas	Unreported catches International waters (9)	Total Catch
1960	1636	-	-	-	-	-	60	100	743	1659	1100	33	-	40	283	139	1443	1	-	7237	-		-
1961	1583	-	-	-	-	-	127	127	707	1533	790	20	-	27	232	132	1185	1	-	6464	-		-
1962	1719	-	-	-	-	-	244	125	1459	1935	710	23	-	45	318	356	1738	1	-	8673	-		-
1963	1861	-	-	-	-	-	466	145	1458	1786	480	28	-	23	325	306	1725	1	-	8604	-		-
1964	2069	-	-	-	-	-	1539	135	1617	2147	590	34	-	36	307	377	1907	1	-	10759	-		-
1965	2116	-	-	-	-	-	861	133	1457	2000	590	42	-	40	320	281	1593	1	-	9434	-		-
1966	2369	-	-	-	-	-	1370	106	1238	1791	570	42	-	36	387	287	1595	1	-	9792	-		-
1967	2863	-	-	-	-	-	1601	146	1463	1980	883	43	-	25	420	449	2117	1	-	11991	-		-
1968	2111	-	5	-	-	-	1127	162	1413	1514	827	38	-	20	282	312	1578	1	403	9793	-		-
1969	2202	-	7	-	-	-	2210	133	1730	1383	360	54	-	22	377	267	1955	1	893	11594	-		-
1970	2323	-	12	-	-	-	2146	195	1787	1171	448	45	-	20	527	297	1392	1	922	11286	-		-
1971	1992	-	-	-	-	-	2689	204	1639	1207	417	16	-	18	426	234	1421	1	471	10735	-		-
1972	1759	-	9	32	34	-	2113	250	1804	1568	462	40	-	18	442	210	1727	1	486	10955	-		-
1973	2434	-	28	50	12	-	2341	256	1930	1726	772	24	-	23	450	182	2006	2.7	533	12770	-		-
1974	2539	-	20	76	13	-	1917	225	2128	1633	709	16	-	32	383	184	1708	0.9	373	11957	-		-
1975	2485	-	28	76	25	-	2030	266	2216	1537	811	27	-	26	447	164	1621	1.7	475	12236	-		-
1976	2506	-	40	66	9	<1	1175	225	1561	1530	772	21	2.5	20	208	113	1019	0.8	289	9557	-		-
1977	2545	-	40	59	19	6	1420	230	1372	1488	497	19	-	10	345	110	1160	2.4	192	9514	-		-
1978	1545	-	37	37	20	8	984	291	1230	1050	476	32	-	10	349	148	1323	4.1	138	7682	-		-
1979	1287	-	119	26	10	<1	1395	225	1097	1831	455	29	-	12	261	99	1076	2.5	193	8118	-		-
1980	2680	-	536	34	30	<1	1194	249	947	1830	664	47	-	17	360	122	1134	5.5	277	10127	-		-
1981	2437	-	1025	44	20	<1	1264	163	685	1656	463	25	-	26	493	101	1233	6	313	9954	-		-
1982	1798	-	865	54	20	<1	1077	147	993	1348	354	10	-	25	286	132	1092	6.4	437	8644	-		-
1983	1424	-	678	58	16	<1	310	198	1656	1550	507	23	3	28	429	187	1221	1.3	466	8755	-		-
1984	1112	-	628	46	25	<1	297	159	829	1623	593	18	3	40	345	78	1013	2.2	101	6912	-		-
1985	1133	-	566	49	22	7	864	217	1595	1561	659	13	3	45	361	98	913	2.1	-	8108	-		-
1986	1559	-	530	37	28	19	960	310	1730	1598	608	27	2.5	54	430	109	1271	1.9	-	9274	-		9274
1987	1784	-	576	49	27	<1	966	222	1239	1385	564	18	2	47	302	56	922	1.2	-	8160	2788		10948
1988	1311	-	243	36	32	4	893	396	1874	1076	419	18	2	40	395	114	882	0.9	-	7736	3248		10984
1989	1139	-	364	52	14	<1	337	278	1079	905	359	7	2	29	296	142	895	1.7	-	5900	2277		8177
1990	911	13	315	60	15	<1	274	426	586	930	315	10	2	33	338	94	624	2.4	-	4948	1890	180-350	6838
1991	711	3.3	95	70	13	4	472	505	404	876	215	15	1	38	200	55	462	0.8	-	4140	1682	25-100	5822
1992	522	10	23	77	20	5	237	635	630	867	166	16	1.3	49	186	91	600	0.7	-	4136	1962	25-100	6098
1993	373	9	21	70	16	-	-	656	543	923	140	14	1.8	56	270	83	547	0.6	-	3723	1644	25-100	5367
1994 (10)	351	6	6	49	18	-	-	448	819	937	138	15	2.7	44	319	91	596	0	-	3840	1276	25-100	5116
Means																							
1989-1993	731	-	164	66	16	5	330	500	648	900	239	12	2	41	258	93	626	1	-	4570	1891	-	6461
1984-1993	1056	-	336	55	21	8	589	380	1051	1174	404	16	2	43	312	92	813	1	-	6304	-	-	-

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Includes catches made in the West Greenland area by Norway, Faroes, Denm
3. Until 1994, includes only those catches sold through dealers.
4. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
5. Before 1966, sea trout and sea charr included (5% of total).
6. Weights estimated from 1994 mean weight. Early years may be underestimates.
7. Not including angling catch (mainly 1SW).
8. Includes catches in Norwegian Sea by vessels from Denmark, Sweden, Germany, Norway and Finland.
9. Estimates refer to season ending in given year.
10. Includes provisional and incomplete data

Table 2.1.2 Nominal catch of SALMON in homewaters by country (in tonnes round fresh weight), 1960-1994. (1994 provisional figures).
S = Salmon (2SW or MSW fish). G = Grilse (1SW fish). Sm = small. Lg = large. T = S + G or Lg + Sm

Year	Canada (1)			Finland			France	Iceland	Ireland (2,3)			Norway (4)			Russia	Spain (5)	Sweden (West)	UK (E&W)	UK(N.I.) (3, 6)	UK(Scotland)			USA	Total (7)
	Lg	Sm	T	S	G	T	T	T	S	G	T	S	G	T	T	T	T	T	T	Lg	Sm	T	T	T
1960	-	-	1636	-	-	-	-	100	-	-	743	-	-	1659	1100	33	40	283	139	971	472	1443	1	7177
1961	-	-	1583	-	-	-	-	127	-	-	707	-	-	1533	790	20	27	232	132	811	374	1185	1	6337
1962	-	-	1719	-	-	-	-	125	-	-	1459	-	-	1935	710	23	45	318	356	1014	724	1738	1	8429
1963	-	-	1861	-	-	-	-	145	-	-	1458	-	-	1786	480	28	23	325	306	1308	417	1725	1	8138
1964	-	-	2069	-	-	-	-	135	-	-	1617	-	-	2147	590	34	36	307	377	1210	697	1907	1	9220
1965	-	-	2116	-	-	-	-	133	-	-	1457	-	-	2000	590	42	40	320	281	1043	550	1593	1	8573
1966	-	-	2369	-	-	-	-	106	-	-	1238	-	-	1791	570	42	36	387	287	1049	546	1595	1	8422
1967	-	-	2863	-	-	-	-	146	-	-	1463	-	-	1980	883	43	25	420	449	1233	884	2117	1	10390
1968	-	-	2111	-	-	-	-	162	-	-	1413	-	-	1514	827	38	20	282	312	1021	557	1578	1	8258
1969	-	-	2202	-	-	-	-	133	-	-	1730	801	582	1383	360	54	22	377	267	997	958	1955	1	8484
1970	1562	761	2323	-	-	-	-	195	-	-	1787	815	356	1171	448	45	20	527	297	775	617	1392	1	8206
1971	1482	510	1992	-	-	-	-	204	-	-	1639	771	436	1207	417	16	18	426	234	719	702	1421	1	7575
1972	1201	558	1759	-	-	32	34	250	200	1604	1804	1064	514	1578	462	40	18	442	210	1013	714	1727	1	8357
1973	1651	783	2434	-	-	50	12	256	244	1686	1930	1220	506	1726	772	24	23	450	182	1158	848	2006	2.7	9868
1974	1589	950	2539	-	-	76	13	225	170	1958	2128	1149	484	1633	709	16	32	383	184	912	716	1628	0.9	9567
1975	1573	912	2485	-	-	76	25	266	274	1942	2216	1038	499	1537	811	27	26	447	164	1007	614	1621	1.7	9703
1976	1721	785	2506	-	-	66	9	225	109	1452	1561	1063	467	1530	772	21	20	208	113	522	497	1019	0.8	8051
1977	1883	662	2545	-	-	59	19	230	145	1227	1372	1018	470	1488	497	19	10	345	110	639	521	1160	2.4	7856
1978	1225	320	1545	-	-	37	20	291	147	1082	1229	668	382	1050	476	32	10	349	148	781	542	1323	4.1	6514
1979	705	582	1287	-	-	26	10	225	105	922	1027	1150	681	1831	455	29	12	261	99	598	478	1076	2.5	6341
1980	1763	917	2680	-	-	34	30	249	202	745	947	1352	478	1830	664	47	17	360	122	851	283	1134	5.5	8120
1981	1619	818	2437	-	-	44	20	163	164	521	685	1189	467	1656	463	25	26	493	101	834	389	1223	6	7342
1982	1082	716	1798	49	5	54	20	147	63	930	993	985	363	1348	364	10	25	286	132	596	496	1092	6.4	6275
1983	911	513	1424	51	7	58	16	198	150	1506	1656	957	593	1550	507	23	28	429	187	672	549	1221	1.3	7298
1984	645	467	1112	37	9	46	25	159	101	728	829	995	628	1623	593	18	40	345	78	504	509	1013	2.2	5883
1985	540	593	1133	38	11	49	22	217	100	1495	1595	923	638	1561	659	13	45	361	98	514	399	913	2.1	6668
1986	779	780	1559	25	12	37	28	310	136	1594	1730	1042	556	1598	608	27	54	430	109	745	526	1271	1.9	7763
1987	951	833	1784	34	15	49	27	222	127	1112	1239	894	491	1385	564	18	47	302	56	503	419	922	1.2	6616
1988	633	677	1310	27	9	36	32	396	141	1733	1874	656	420	1076	419	18	40	395	114	501	381	882	0.9	6593
1989	590	549	1139	33	19	52	14	278	132	947	975	469	436	905	359	7	29	296	142	464	431	895	1.7	5093
1990	486	425	911	41	19	60	15	426	-	-	586	545	385	930	315	10	33	338	94	423	201	624	2.4	4344
1991	370	341	711	53	17	69	13	505	-	-	404	535	342	876	215	15	38	200	55	177	285	462	0.8	3564
1992	323	199	522	49	28	77	20	635	-	-	630	566	301	867	166	16	49	186	91	362	238	600	0.7	3860
1993	214	159	373	53	17	70	16	656	-	-	543	611	312	923	140	14	56	270	83	320	227	547	0.6	3692
1994 (8)	213	138	351	38	11	49	18	448			819	548	389	937	138	15	44	319	91	365	231	596	0	3825
Means																								
1989-93	397	335	731	46	20	66	16	500	132	947	628	545	355	900	239	12	41	258	93	349	276	626	1	4110
1984-93	553	502	1055	39	16	55	21	380	123	1268	1041	724	451	1174	404	16	43	312	92	451	362	813	1	5408

1. Includes estimates of some local sales, and, prior to 1984, by-catch.
2. Until 1994, includes only those catches sold through dealers.
3. Catch on River Foyle allocated 50% Ireland and 50% N. Ireland.
4. Before 1966, sea trout and sea charr included (5% of total).
5. Weights estimated from 1994 mean weight. Early years may be underestimates.
6. Not including angling catch (mainly 1SW).
7. 0.08t reported by Portugal not included in 1987
8. Includes provisional and incomplete data

Table 2.2.1 Reported catch of SALMON in numbers and weight in tonnes (round fresh weight). Catches reported for 1994 may be provisional or incomplete. Methods used for estimating age composition given in footnotes.

Country	Year	1SW		2SW		3SW		4SW		5SW		MSW[1]		PS		Total	
		No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
Canada	1982	358,000	716	-	-	-	-	-	-	-	-	240,000	1,082	-	-	598,000	1,798
	1983	265,000	513	-	-	-	-	-	-	-	-	201,000	911	-	-	466,000	1,424
	1984	234,000	467	-	-	-	-	-	-	-	-	143,000	645	-	-	377,000	1,112
	1985	333,084	593	-	-	-	-	-	-	-	-	122,621	540	-	-	455,705	1,133
	1986	417,269	780	-	-	-	-	-	-	-	-	162,305	779	-	-	579,574	1,731
	1987	435,799	833	-	-	-	-	-	-	-	-	203,731	951	-	-	639,530	1,784
	1988	372,178	677	-	-	-	-	-	-	-	-	137,637	633	-	-	509,815	1,311
	1989	304,620	549	-	-	-	-	-	-	-	-	135,484	590	-	-	440,104	1,139
	1990	233,690	425	-	-	-	-	-	-	-	-	106,379	486	-	-	340,069	911
	1991	189,324	341	-	-	-	-	-	-	-	-	82,532	370	-	-	271,856	711
	1992	108,901	199	-	-	-	-	-	-	-	-	66,357	323	-	-	175,258	522
	1993	91,239	159	-	-	-	-	-	-	-	-	45,416	214	-	-	136,655	373
	1994	76,697	138	-	-	-	-	-	-	-	-	42,424	213	-	-	119,121	351
Faroe Islands	1982/83	9,086	-	101,227	-	21,663	-	448	-	29	-	-	-	-	-	132,453	625
	1983/84	4,791	-	107,199	-	12,469	-	49	-	-	-	-	-	-	-	124,453	651
	1984/85	324	-	123,510	-	9,690	-	-	-	-	-	-	-	1,653	-	135,776	598
	1985/86	1,672	-	141,740	-	4,779	-	76	-	-	-	-	-	6,287	-	154,554	545
	1986/87	76	-	133,078	-	7,070	-	80	-	-	-	-	-	-	-	140,304	539
	1987/88	5,833	-	55,728	-	3,450	-	0	-	-	-	-	-	-	-	65,011	208
	1988/89	1,351	-	86,417	-	5,728	-	0	-	-	-	-	-	-	-	93,496	309
	1989/90	1,560	-	103,407	-	6,463	-	6	-	-	-	-	-	-	-	111,430	364
	1990/91	631	-	52,420	-	4,390	-	8	-	-	-	-	-	-	-	57,442	202
	1991/92	16	-	7,611	-	837	-	-	-	-	-	-	-	-	-	8,464	31
	1992/93	-	-	4,212	-	1,203	-	-	-	-	-	-	-	-	-	5,415	22
	1993/94	-	-	1,866	-	206	-	-	-	-	-	-	-	-	-	2,072	7
Finland	1982	2,598	5	-	-	-	-	-	-	-	-	5,408	49	-	-	8,406	54
	1983	3,916	7	-	-	-	-	-	-	-	-	6,050	51	-	-	9,966	58
	1984	4,899	9	-	-	-	-	-	-	-	-	4,726	37	-	-	9,625	46
	1985	6,201	11	-	-	-	-	-	-	-	-	4,912	38	-	-	11,113	49
	1986	6,131	12	-	-	-	-	-	-	-	-	3,244	25	-	-	9,375	37
	1987	8,696	15	-	-	-	-	-	-	-	-	4,520	34	-	-	13,216	49
	1988	5,926	9	-	-	-	-	-	-	-	-	3,495	27	-	-	9,421	36
	1989	10,395	19	-	-	-	-	-	-	-	-	5,332	33	-	-	15,727	52
	1990	10,084	19	-	-	-	-	-	-	-	-	5,600	41	-	-	15,684	60
	1991	9,213	17	-	-	-	-	-	-	-	-	6,298	53	-	-	15,511	70
	1992	15,017	28	-	-	-	-	-	-	-	-	6,284	49	-	-	21,301	77
	1993	11,157	17	-	-	-	-	-	-	-	-	8,180	53	-	-	19,337	70
	1994	7,493	11	-	-	-	-	-	-	-	-	6,230	38	-	-	13,723	49
France	1985	1,074	-	-	-	-	-	-	-	-	-	3,278	-	-	-	4,352	22
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,801	28
	1987	6,013	18	-	-	-	-	-	-	-	-	1,806	9	-	-	7,819	27
	1988	2,063	7	-	-	-	-	-	-	-	-	4,964	25	-	-	7,027	32
	1989	1,124	3	1,971	9	311	2	-	-	-	-	-	-	-	-	3,406	14
	1990	1,886	5	2,186	9	146	1	-	-	-	-	-	-	-	-	4,218	15
	1991	1,362	3	1,935	9	190	1	-	-	-	-	-	-	-	-	3,487	13
	1992	2,490	7	2,450	12	221	2	-	-	-	-	-	-	-	-	5,161	20
	1993	3,581	10	987	4	267	2	-	-	-	-	-	-	-	-	4,835	16
	1994	2,810	7	2,250	10	40	1	-	-	-	-	-	-	-	-	5,100	18

Table 2.2.1 Continued

Iceland	1982	23,026	58	-	-	-	-	-	-	-	-	18,119	89	-	-	41,145	147
	1983	33,769	85	-	-	-	-	-	-	-	-	24,454	113	-	-	58,223	198
	1984	18,901	47	-	-	-	-	-	-	-	-	22,188	112	-	-	41,089	159
	1985	50,000	125	-	-	-	-	-	-	-	-	16,300	94	-	-	66,300	217
	1986	67,300	174	-	-	-	-	-	-	-	-	22,300	136	-	-	89,600	310
	1987	42,550	114	-	-	-	-	-	-	-	-	18,840	108	-	-	61,390	222
	1988	112,000	288	-	-	-	-	-	-	-	-	19,000	108	-	-	133,500	396
	1989	70,817	158	-	-	-	-	-	-	-	-	20,037	115	-	-	90,854	278
	1990	98,241	-	-	-	-	-	-	-	-	-	34,267	-	-	-	132,508	426
	1991	144,639	-	-	-	-	-	-	-	-	-	30,510	-	-	-	175,149	505
	1992	149,783	-	-	-	-	-	-	-	-	-	34,683	-	-	-	184,466	590
	1993	185,188	-	-	-	-	-	-	-	-	-	32,188	-	-	-	217,649	657
	1994	98,782	271	-	-	-	-	-	-	-	-	30,331	177	-	-	129,113	448
Ireland	1980	248,333	745	-	-	-	-	-	-	-	-	39,608	202	-	-	287,941	947
	1981	173,667	521	-	-	-	-	-	-	-	-	32,159	164	-	-	205,826	685
	1982	310,000	930	-	-	-	-	-	-	-	-	12,353	63	-	-	322,353	993
	1983	502,000	1,506	-	-	-	-	-	-	-	-	29,411	150	-	-	531,411	1,656
	1984	242,666	728	-	-	-	-	-	-	-	-	19,804	101	-	-	262,470	829
	1985	498,333	1,495	-	-	-	-	-	-	-	-	19,608	100	-	-	517,941	1,595
	1986	498,125	1,594	-	-	-	-	-	-	-	-	28,335	136	-	-	526,450	1,730
	1987	358,842	1,112	-	-	-	-	-	-	-	-	27,609	127	-	-	386,451	1,239
	1988	559,297	1,733	-	-	-	-	-	-	-	-	30,599	141	-	-	589,896	1,874
	1989	-	-	-	-	-	-	-	-	-	-	-	-	-	-	330,558	1,079
	1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	194,785	586
	1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	135,600	404
	1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	235,153	630
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200,282	543
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	290,731	819
Norway	1981	221,566	467	-	-	-	-	-	-	-	-	213,943	1,189	-	-	435,509	1,656
	1982	163,120	363	-	-	-	-	-	-	-	-	174,229	985	-	-	337,349	1,348
	1983	278,061	593	-	-	-	-	-	-	-	-	171,361	957	-	-	449,442	1,550
	1984	294,365	628	-	-	-	-	-	-	-	-	176,716	995	-	-	471,081	1,623
	1985	299,037	638	-	-	-	-	-	-	-	-	162,403	923	-	-	461,440	1,561
	1986	264,849	556	-	-	-	-	-	-	-	-	191,524	1,042	-	-	456,373	1,598
	1987	235,703	491	-	-	-	-	-	-	-	-	153,554	894	-	-	389,257	1,385
	1988	217,617	420	-	-	-	-	-	-	-	-	120,367	656	-	-	337,984	1,076
	1989	220,170	436	-	-	-	-	-	-	-	-	80,880	469	-	-	301,050	905
	1990	192,500	385	-	-	-	-	-	-	-	-	91,437	545	-	-	286,466	930
	1991	171,041	342	-	-	-	-	-	-	-	-	92,214	535	-	-	263,255	876
	1992	151,291	301	-	-	-	-	-	-	-	-	92,717	566	-	-	244,008	867
	1993	153,412	312	-	-	-	-	-	-	-	-	99,519	611	-	-	252,931	923
	1994	190,199	389	-	-	-	-	-	-	-	-	91,806	548	-	-	282,005	937
Russia	1987	97,242	-	27,135	-	9,539	-	556	-	18	-	-	-	2,521	-	139,011	564
	1988	53,158	-	33,395	-	10,256	-	294	-	25	-	-	-	2,937	-	100,066	419
	1989	78,023	-	23,123	-	4,118	-	26	-	-	-	-	-	2,187	-	107,477	359
	1990	70,595	-	20,633	-	2,919	-	101	-	-	-	-	-	2,010	-	96,258	315
	1991	40,603	-	12,458	-	3,060	-	650	-	-	-	-	-	1,375	-	58,146	215
	1992	34,021	-	8,880	-	3,547	-	180	-	-	-	-	-	824	-	47,452	166
	1993	28,100	-	11,780	-	4,280	-	377	-	-	-	-	-	1,470	-	46,007	140
	1994	30,877	-	10,879	-	2,183	-	51	-	-	-	-	-	555	-	44,545	138
Sweden	1989	3,181	7	-	-	-	-	-	-	-	-	4,610	22	-	-	7,791	29
	1990	7,428	18	-	-	-	-	-	-	-	-	3,133	15	-	-	10,561	33
	1991	8,987	20	-	-	-	-	-	-	-	-	3,620	18	-	-	12,607	38
	1992	9,850	23	-	-	-	-	-	-	-	-	4,656	26	-	-	14,507	49
	1993	10,540	23	-	-	-	-	-	-	-	-	6,369	33	-	-	16,909	56
	1994	8,304	18	-	-	-	-	-	-	-	-	4,661	26	-	-	12,695	44

Table 2.2.1 Continued

UK (England & Wales)	1985	-	-	-	-	-	-	-	-	-	-	-	-	-	-	95,531	361
	1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110,794	430
	1987	66,371	-	-	-	-	-	-	-	-	-	17,063	-	-	-	83,434	302
	1988	76,521	-	-	-	-	-	-	-	-	-	33,642	-	-	-	110,163	395
	1989	65,450	-	-	-	-	-	-	-	-	-	19,550	-	-	-	85,000	296
	1990	53,143	-	-	-	-	-	-	-	-	-	33,533	-	-	-	86,676	338
	1991	34,596	-	-	-	-	-	-	-	-	-	17,053	-	-	-	51,649	199
	1992	33,038	-	-	-	-	-	-	-	-	-	15,130	-	-	-	48,168	186
	1993	43,506	-	-	-	-	-	-	-	-	-	31,802	-	-	-	75,308	270
	1994	61,590	-	-	-	-	-	-	-	-	-	26,396	-	-	-	87,986	319
UK (Scotland)	1982	208,061	416	-	-	-	-	-	-	-	-	128,242	596	-	-	336,303	1,092
	1983	209,617	549	-	-	-	-	-	-	-	-	145,961	672	-	-	320,578	1,221
	1984	213,079	509	-	-	-	-	-	-	-	-	107,213	504	-	-	230,292	1,013
	1985	158,012	399	-	-	-	-	-	-	-	-	114,648	514	-	-	272,660	913
	1986	202,861	526	-	-	-	-	-	-	-	-	148,398	745	-	-	351,259	1,271
	1987	164,785	419	-	-	-	-	-	-	-	-	103,994	503	-	-	268,779	922
	1988	149,098	381	-	-	-	-	-	-	-	-	112,162	501	-	-	261,260	882
	1989	174,941	431	-	-	-	-	-	-	-	-	103,886	464	-	-	278,827	895
	1990	81,094	201	-	-	-	-	-	-	-	-	87,924	423	-	-	169,018	624
	1991	73,608	177	-	-	-	-	-	-	-	-	65,193	285	-	-	138,801	462
	1992	101,676	238	-	-	-	-	-	-	-	-	82,841	361	-	-	184,517	600
	1993	94,517	227	-	-	-	-	-	-	-	-	71,726	320	-	-	166,243	547
	1994	92,663	231	-	-	-	-	-	-	-	-	77,191	365	-	-	169,854	596
USA	1982	33	-	1,206	-	5	-	-	-	-	-	-	-	21	-	1,265	6.4
	1983	26	-	314	1.2	2	-	-	-	-	-	-	-	6	-	348	1.3
	1984	50	-	545	2.1	2	-	-	-	-	-	-	-	12	-	609	2.2
	1985	23	-	528	2.0	2	-	-	-	-	-	-	-	13	-	557	2.1
	1986	76	-	482	1.8	2	-	-	-	-	-	-	-	3	-	541	1.9
	1987	33	-	229	1.0	10	-	-	-	-	-	-	-	10	-	282	1.2
	1988	49	-	203	0.8	3	-	-	-	-	-	-	-	4	-	259	0.9
	1989	157	0.3	325	1.3	2	-	-	-	-	-	-	-	3	-	487	1.7
	1990	52	0.1	562	2.2	12	-	-	-	-	-	-	-	16	-	642	2.4
	1991	48	0.1	185	0.7	1	-	-	-	-	-	-	-	4	-	238	0.8
	1992	54	0.1	138	0.6	1	-	-	-	-	-	-	-	-	-	193	0.7
	1993	17	-	133	0.5	-	-	-	-	-	-	-	-	2	-	152	0.6
	1994	12	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-
West Greenland	1982	315,532	-	17,810	-	-	-	-	-	-	-	-	-	2,688	-	336,030	1,077
	1983	90,500	-	8,100	-	-	-	-	-	-	-	-	-	1,400	-	100,000	310
	1984	78,942	-	10,442	-	-	-	-	-	-	-	-	-	630	-	90,014	297
	1985	292,181	-	18,378	-	-	-	-	-	-	-	-	-	934	-	311,493	864
	1986	307,800	-	9,700	-	-	-	-	-	-	-	-	-	2,600	-	320,100	960
	1987	297,128	-	6,287	-	-	-	-	-	-	-	-	-	2,898	-	306,313	966
	1988	281,356	-	4,602	-	-	-	-	-	-	-	-	-	2,296	-	288,233	893
	1989	110,359	-	5,379	-	-	-	-	-	-	-	-	-	1,875	-	117,613	337
	1990	97,271	-	3,346	-	-	-	-	-	-	-	-	-	860	-	101,478	274
	1991	167,551	415	8,809	53	-	-	-	-	-	-	-	-	743	4	177,052	472
	1992	82,354	217	2,822	18	-	-	-	-	-	-	-	-	364	2	85,381	237
	1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] MSW includes all sea ages >1, when this cannot be broken down.
Different methods are used to separate 1SW and MSW salmon in different countries:
- Scale reading: Faroe Islands, France, Russia, UK (England and Wales), USA and West Greenland.
- Size (split weight/length): Canada (2.7 kg for nets; 63cm for rods), Finland (3 kg), Iceland (various splits used at different times and places), Norway (3 kg), UK (Scotland) (3 kg in some places and 3.7 kg in others). All countries except Scotland report no problems with using weight to catergorise catches into sea age classes. In Scotland, misclassification may be very high in some years.

In 1994: Norway catch data are estimated from the average of the previous four years; in USA, no harvest of MSW salmon was permitted.

Table 2.3.1 Guess-estimates of unreported catches in tonnes within national EEZs in the North-East Atlantic, North American and West Greenland Commissions of NASCO.

Year	Unreported catches (tonnes)			
	North-East Atlantic	North American	West Greenland	Total
1986	-	315	-	315
1987	2,554	234	-	2,788
1988	3,087	161	-	3,248
1989	2,103	174	-	2,277
1990	1,779	111	-	1,890
1991	1,555	127	-	1,682
1992	1,825	137	-	1,962
1993	1,471	161	12	1,644
1994	1,157	107	12	1,276
Mean 1989-1993	1,747	142	-	1,891

Table 3.1.1 Production of farmed salmon in the North Atlantic area (in tonnes round fresh weight), 1980-1994.

Year	Norway	UK (Scot.)	Faroes	Canada	Ireland	USA	Iceland	UK (N.Ire.)	Russia	**Total**
1980	4,153	598	-	11	21	-	-	-	-	4,783
1981	8,422	1,133	-	21	35	-	-	-	-	9,611
1982	10,266	2,152	70	38	100	-	-	-	-	12,626
1983	17,000	2,536	110	69	257	-	-	-	-	19,972
1984	22,300	3,912	120	227	385	-	-	-	-	26,944
1985	28,655	6,921	470	359	700	-	91	-	-	37,196
1986	45,675	10,337	1,370	672	1,215	-	123	-	-	59,392
1987	47,417	12,721	3,530	1,334	2,232	365	490	-	-	68,089
1988	80,371	17,951	3,300	3,542	4,700	455	1,053	-	-	111,372
1989	124,000	28,553	8,000	5,865	5,063	905	1,480	-	-	173,866
1990	165,000	32,351	13,000	7,810	5,983	2,086	2,800	<100	5	229,135
1991	155,000	40,593	15,000	9,395	9,483	4,560	2,680	100	0	236,811
1992	140,000	36,101	17,000	10,380	9,231	5,850	2,100	200	0	220,862
1993	170,000	48,691	16,000	11,115	12,366	6,755	2,348	<100	0	267,375
1994	215,000	64,066	14,789	12,496 [1]	11,616	6,130	2,588	<100	0	326,785
Mean 1989-93	150,800	37,258	13,800	8,913	8,425	4,031	2,282	60	1	225,610

[1] Composed of 46t Nfld, 403t NS, 12,000t NB and 15t PQ

Table 3.2.1 Production of ranched salmon in the North Atlantic area (tonnes round fresh weight), 1980-1994

Year	Iceland commercial ranching	Ireland River Burrishoole[1]	UK (N. Ireland) River Bush[1]	Norway various facilities[1]	Total production
1980	8				8
1981	16				16
1982	17				17
1983	32				32
1984	20				20
1985	55	5	17		77
1986	69	11	22		102
1987	38	20	7		65
1988	179	9	12	4	204
1989	136	8	17	3	164
1990	280	2	5	6	293
1991	375	6	4	5	390
1992	460	4	11	10	485
1993	496	4	8	11	519
1994	308	7	0.4	9.5	325
Mean 1989-93	349	5	9	7	370

[1]Total yield in homewater fisheries and rivers.

Table 4.1.2.1. Nominal landings of Atlantic salmon by Faroes vessels in years 1982-1994 and the seasons 1981/1982 - 1993/1994.

Year	Catch (t)	Season	Catch (t)
1982	606	1981/1982	796
1983	678	1982/1983	625
1984	628	1983/1984	651
1985	566	1984/1985	598
1986	530	1985/1986	545
1987	576	1986/1987	539
1988	243	1987/1988	208
1989	364	1988/1989	309
1990	315	1989/1990	364
1991	95	1990/1991	202
Research fishery			
1992	23	1991/1992	31
1993	23	1992/1993	22
1994	6	1993/1994	7

Table 4.1.2.2. Catch in number of salmon by month in the Faroes fishery for the seasons 1983/1984 to 1993/1994.

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
1983/1984	8,680	24,882	12,504	26,396	32,712	12,486	6,849	-	124,509
1984/1985	5,884	20,419	14,493	24,380	26,035	25,471	19,095	-	135,777
1985/1986	1,571	27,611	13,992	50,146	25,968	21,209	14,057	-	154,554
1986/1987	1,881	19,693	5,905	15,113	35,241	21,953	39,153	1,365	140,304
1987/1988	4,259	27,125	5,803	9,387	9,592	4,203	4,642	-	65,011
1988/1989	17,019	24,743	2,916	4,663	12,457	31,698			93,496
1989/1990	13,079	40,168	5,533	11,282	11,379	29,504	570		111,515
1990/1991	6,921	28,972	3,720	7,996	6,275	3,557	-		57,441
Reserch fishery excluding discards and tagged fish									
1991/1992	-	3,842	-	931	3,039	652	-	-	8,464
1992/1993	1,282	334	-	-	3,799	-	-	-	5,415
1993/1994	876	560	-	178	458	-	-	-	2,072

Table 4.1.2.3. Estimation of discard rates in the Faroes fishery since the 1982/1983 season.

	No. of samples	Number sampled	Number >= 60 cm	Discard rate %	Range %
1982/1983	7	6,820	472	6.9	0 - 10.4
1983/1984	5	4,467	176	3.9	-
1984/1985	12	9,546	1,289	13.5	3.0 - 32.0
1985/1986	7	14,654	286	1.8	0.6 - 13.8
1986/1987	13	39,758	2,849	7.2	0 - 71.3
1987/1988	2	1,499	235	15.6	-
1988/1989	9	17,235	1,804	10.7	0.4 - 31.9
1989/1990	5	16,375	1,533	9.4	3.6 - 18.5
1990/1991	3	4,615	681	14.8	9.9 - 17.5
1991/1992	6	9,350	825	8.8	2.4 - 15.9
1992/1993	3	9,099	853	9.4	5.1 - 32.3
1993/1994	4	3,035	436	14.4	1.5 - 48.6

Table 4.1.3.1. Catch of salmon in number per unit effort (1,000 hooks) by month in the Faroes longline fishery south of 65°30'N in the seasons 1981/1982 to 1993/1994.

Season	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Season
1981/1982	-	38	41	49	58	51	34	-	46
1982/1983	19	120	-	61	50	39	36	40	48
1983/1984	85	80	86	58	45	28	26	-	51
1984/1985	38	38	32	32	37	39	40	-	36
1985/1986	64	52	68	54	48	78	61	-	56
1986/1987	31	43	34	44	70	111	102	-	64
1987/1988	56	51	-	47	34	25	22	-	43
1988/1989	63	80	48	68	61	76	-	-	71
1989/1990	81	86	38	56	87	77	-	-	76
1990/1991	81	97	-	35	39	51	-	-	67
1991/1992	-	93	-	72	77	50	-	-	79
1992/1993	76	55	-	-	92	-	-	-	84
1993/1994	67	53	-	13	45	-	-	-	43

Table 4.1.4.1. Faroes salmon sampling data in the 1993/1994 season (number of fish).

Trip	Measured	Scales	Stomachs	Weight	Extern tags	Adipose fincl.	Micro tags	Tagged & released
01-12-93	1111	436	250	260	10	32	6	176
16-12-93	823	396	250	253	8	22	7	143
10-02-94	271	210	143	146	8	6	1	64
10-03-94	173	171	124	124	1	8	2	43
22-03-94	656	497	306	356	6	29	3	191
Total	3034	1710	1073	1139	33	97	19	617

Table 4.1.4.2. Proportion of farmed salmon in samples from the Faroes salmon fisheries in the period 1989-1994. Indet.= number of fish not possible to classify.

Season	Time	Year	Wild	Reared	Indet.	Total	% reared
1982/83	February	1983	48	1	1	50	2
	March	1983	63	1	2	66	2
	April	1983	63	0	5	68	0
1982/83	Febr.-April	1983	174	2	8	184	1
1985/86	January	1986	52	2	3	57	4
	February	1986	53	4	3	60	7
	April	1986	75	2	1	78	3
1985/86	Jan.-April	1986	180	8	7	195	4
1986/87	March	1987	136	2	2	140	1
	April	1987	67	2	1	70	3
1986/87	March-April	1987	203	4	3	210	2
1987/88	January	1988	45	3	2	50	6
	February	1988	73	10	3	86	12
	April	1988	82	4	1	87	5
1987/88	Jan.-April	1988	200	17	6	223	8
1989/90	February	1990	36	32	5	73	44
1990/91	December	1990	49	42	8	99	42
1991/92	December	1991	71	43	5	119	36
	February	1992	76	76	6	158	48
	March	1992	57	20	2	79	25
	April	1992	66	27	5	98	28
1991/92	Dec.1991-April 1992		271	166	18	454	37
1992/93	Nov.-Dec.	1992	65	26	28	119	22
	March	1993	125	61	14	200	31
1992/93	Nov.1992-March 1993		191	87	41	319	27
1993/94	November	1993	54	13	8	75	17
	December	1993	36	9	3	48	19
	January	1994	15	5	5	25	20
	February	1994	62	13	4	79	17
	March	1994	54	11	8	73	15
1993/94	Nov. 1993-April 1994		221	51	28	300	17

Table 4.1.4.3. Catch in number by sea age class by month in the Faroes Faroes salmon fishery in 1992/1993. Wild fish only, including discards.

	Sea age								
Month	1	%	2	%	3	%	4+	%	Total
Nov-Dec	166	12.5	963	72.7	196	14.8	0	0.0	1,324
Jan-Mar	155	22.9	325	48.1	180	26.7	16	2.3	675
Total	320	16.0	1,288	64.4	376	18.8	16	0.8	2,000

Table 4.1.4.4. Catch in number by sea age class by fishing seasons in the Faroes salmon fishery since 1991/1992. Including discards and excluding reared fish. Tagged fish is also excluded.

Season	1	%	2	%	3	%	4	%	Total
1991/1992	248	4	4,686	83	743	13	+	+	5,677
1992/1993	521	12	2,646	61	1,120	26	68	2	4,355
1993/1994	320	16	1,288	64	376	19	16	1	2,000

Table 4.1.4.5. Percentage distribution by weight category (kg) of salmon landed at Faroes from 1983/1984 to 1993/1994 fishing season.

	Weight category (kg)						
Season	<2.5	2.5-3	3-4	4-5	5-7	7-9	> 9
1983/1984	9.7	20.1	41.5	14.2	4.7	6.2	3.6
1984/1985	13.3	21.4	42.3	11.7	3.6	4.9	2.8
1985/1986	9.6	18.3	46.4	16.4	5.3	2.8	1.2
1986/1987	24.4	26.5	30.9	9.1	4.1	3.5	1.5
1987/1988	35.8	26.6	24.3	5.6	4.6	2.3	0.8
1988/1989	26.4	26.2	33.9	7.9	3.2	2.0	0.4
1989/1990	24.4	23.8	37.8	8.9	3.2	1.5	0.4
1990/1991	13.2	20.1	38.8	13.0	7.6	4.8	3.0
1991/1992	13.0	14.1	31.1	11.0	10.0	13.1	7.7
1992/1993	7.2	15.5	24.3	9.7	18.5	17.8	6.9
1993/1994	21.3	26.4	31.2	5.6	6.3	7.3	1.9

Table 4.1.4.6. Smolt age compositions (%) of wild salmon in samples from the Faroese fishery in the 1993/94 season. (Indet = number of fish not possible to age; n = number of fish examined).

	Smolt age							
Period	1	2	3	4	5	6	Indet	n
Nov-Dec	9.6	42.5	34.3	13.7	0	0	17	73
Jan-Mar	3.7	37.4	43.9	15.0	0	0	24	107
Total	6.1	39.5	40.0	14.5	0	0	41	180

Table 4.1.4.7. Smolt age distribution (%) from samples taken in the Faroes fishery from 1984/1985 to 1992/1993.

	Smolt age						Number	
Season	1	2	3	4	5	6	Unknown	Total
1984/1985	1.5	37.9	46.9	12.3	1.5	0.1	0	2194
1985/1986	0.8	20.4	52.7	24.4	1.7	0	0	951
1986/1987	0.2	16.2	48.5	31.8	3.1	0.2	0	575
1987/1988	1.2	35.9	49.5	13.2	0.4	0	0	680
1988/1989	3.6	47.9	41.2	7.1	0.3	0	14	798
1989/1990	3.9	52.5	35.7	6.7	1.1	0	2	358
1990/1991			No scale samples					
1991/1992	2.9	42.8	48.1	5.8	0.4	0	26	271
1992/1993	4.3	39.9	46.6	8.6	0.6	0	0	145
1993/1994	7.6	40.8	37.5	14.1	0.0	0	41	180

Table 4.1.4.8. Sampling details of salmon stomachs sampled in the 1992/1993 and 1993/94 fishing season at Faroes.

	1992/1993		1993/1994	
	Number	%	Number	%
Number sampled	1272		1073	
Number analysed so far	1272	100	560	100
Number empty or containing only bait (sprat)	308	24.2	175	31.2
Number with food	964	75.8	385	68.2

Table 4.1.4.9. The frequency (%) with which the main food groups occurred in salmon stomachs containing food in the 1992/1993 and 1993/94 fishing season at Faroes.

Main prey groups	1992/93	1993/94	Principal prey genera
Crustaceans	79.6	88.8	Euphasiids, Hyperiid amphipods and Shrimps
Fish	74.9	40.8	Lantern fishes, Barracudinas, Silversides
Squid	1.3	1.3	Gonatus sp.
Annelids	0.9	1.6	Annelids

Table 4.1.5.1 Estimated numbers of discards, 1SW and 2SW microtagged salmon caught in the Faroese fishery from smolts released between 1984 and 1993 (year of fishery for 2SW fish is yr(n+1))

Year of smolt migration yr (n)	Country of origin	Number released	Discards yr(n)	No. in catch 1SW yr(n)	all 1SW yr(n)	2SW yr(n+1)	Total	Recaps/ releases x 10^{-3}
1984	Faroe Islands	19,602	-	-	-	9	9	0.46
	Ireland	260,816	246	-	246	15	261	1.00
	N. Iceland	72,352	33	-	33	-	33	0.45
	UK (E & W)	39,780	-	-	-	3	3	0.08
	UK (Scotland)	30,040	49	-	49	-	49	1.64
1985	Faroe Islands	30,079	-	-	-	87	87	2.89
	Ireland	220,000	86	-	86	3	89	0.40
	UK (E & W)	53,347	-	-	-	12	12	0.22
	UK (Scotland)	13,497	-	-	-	3	3	0.22
1986	Faroe Islands	43,000	-	-	-	54	54	1.26
	Ireland	143,866	30	-	30	11	41	0.29
	UK (E & W)	177,071	8	-	8	8	16	0.09
	UK (N. Ireland)	26,320	15	-	15	-	15	0.58
	UK (Scotland)	16,217	8	-	8	-	8	0.47
1987	Ireland	162,189	154	3	157	4	161	0.99
	N. Iceland	27,978	-	3	3	27	30	1.06
	UK (E & W)	195,373	51	-	51	25	77	0.39
	UK (N. Ireland)	20,145	-	-	-	2	2	0.09
	UK (Scotland)	20,876	-	-	-	4	4	0.17
	USA	640,000	-	-	-	2	2	<0.01
1988	Canada	13322	6	-	-	-	6	0.45
	Faroe Islands	43,481	12	-	12	69	81	1.87
	Ireland	165,841	104	-	104	7	111	0.67
	UK (E & W)	189,913	12	0	12	14	26	0.14
	UK (Scotland)	31,331	12	-	12	-	12	0.39
1989	Faroe Islands	26943	-	-	-	8	8	0.28
	Ireland	185,439	105	-	105	-	105	0.57
	N. Iceland	85452	-	-	-	4	4	0.04
	UK (E & W)	256,342	23	-	23	15	38	0.15
	UK (Scotland)	30288	-	-	-	4	4	0.13
1990	Faroe Islands	11820	-	-	-	3	3	0.25
	Ireland	153,821	44	-	44	1	45	0.29
	UK (E & W)	250,024	15	-	15	1	16	0.06
	UK (N. Ireland)	29,875	15	-	15	-	15	0.49
	UK (Scotland)	41,390	15	-	15	2	17	0.40
1991	Faroe Islands	n/a	1	-	1	-	1	n/a
	Ireland	471,152	19	-	19	4	23	0.05
	UK (E & W)	231,205	3	-	3	4	7	0.03
	UK (Scotland)	45,752	-	-	-	1	-	<0.01
	France	21,376	1	-	1	-	1	0.05
1992	Ireland	298,968	11	1	12	4	16	0.05
	Norway	34,700	-	-	-	6	6	0.17
	UK (E & W)	401,085	1	1	2	1	3	0.01
1993	Iceland	314,147	1	-	-	n/a	1	<0.01
	Ireland	362,854	6	-	-	n/a	6	0.02
	Spain	n/a	1	-	-	n/a	1	n/a

n/a = not available

Table 4.1.5.2 Comparison of the tag recoveries (CWT and External tags) from fish of all ages in the Faroes fishery per 1,000 released in each country. External tag reporting rate 1975-1990 = 0.75, 1991-1993 = 1.

Year of smolt migration	Coded Wire Tags									External tags		
	Canada	Faroes	France	Northern Iceland	Ireland	UK (E&W)	UK (N.Ire.)	UK (Scot.)	USA	UK(Scot) N. Esk	Sweden	Norway
1975											0.23	
1976											0.53	
1977											2.63	
1978											6.00	
1979											3.57	
1980										1.16	8.03	3.11
1981										2.83	16.09	9.39
1982										3.37	13.19	8.37
1983										0.92	10.20	4.04
1984	-	0.46		0.45	1	0.08		1.64		0.61	4.43	5.36
1985	-	2.89		-	0.4	0.22		0.22	-	0.85	4.24	3.97
1986	-	1.26		-	0.29	0.09	0.58	0.47	-	-	7.31	1.13
1987	-	-		1.06	0.99	0.39	0.09	0.17	<0.01	-	9.55	2.16
1988	0.45	1.87		-	0.67	0.14	-	0.39	-	0.69	1.45	2.27
1989	-	0.28		0.04	0.57	0.15	-	0.13	-	0.80	4.11	2.49
1990	-	0.25		-	0.29	0.06	0.49	0.4	-	0.08	0.57	0.00
1991	-	-	0.05	-	0.05	0.04	-	<0.01	-	0.11	0.81	0.00
1992	-	-	-	-	0.05	0.01	-	-	-	-	0.43	0.00
1993	-	-	-	-	0.02	-	-	-	-	-	n/a	0.00

\- = tagged fish released in this year but no recoveries reported in Faroese fishery

Table 4.1.6.1 Estimated exploitation rates of 1SW and 2SW salmon in the Faroes Fishery. Estmates are based on recoveries of external tags (Norway, Scotland, Sweden) or micro tags (Ireland, UK N. Ireland).

	Exploitation Rates %																
	Ireland		Norway						Scotland			Sweden		UK (N. Ireland	
	R Burrishole		R. Drammen		River Isma				North Esk			R. Lagan		R Bush	
Season	Hatchery		Hatchery		Wild		Hatchery		Wild			Hatchery		Wild/Hatchery	
	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	3SW	1SW	2SW	1SW	2SW
1981/82	0	0	-	-	0	-	1	-	0	**6**	0	-	-	-	-
1982/83	0	0	-	-	0	**25**	**2**	**38**	1	**10**	6	-	-	-	-
1983/84	0	0	-	-	0	50	1	**45**	0	**10**	18	-	-	0	-
1984/85	1	0	**5**	-	0	33	**2**	**39**	0	9	10	0	-	0	0
1985/86	<1	0	0	**30**	0	38	0	**30**	**<1**	5	0	3	22	0	0
1986/87	<1	0	0	3	0	13	1	**28**	0	6	0	2	0	<1	0
1987/88	1	0	0	6	0	5	1	21	0	0	0	0	9	0	0
1988/89	<1	0	0	**36**	0	3	0	**10**	4	0	0	0	13	<1	0
1989/90	1	0	0	**45**	0	5	0	**15**	2	0	0	1	21	0	0
1990/91	0	0	1	**13**	0	13	0	**36**	<1	2	0	1	**18**	<1	0
1991/92	0	0	-	2	0	4	**<1**	1	<1	0	0	1	3	0	0
1992/93	0	<1	0	-	0	6	1	5	-	0	0	0	12	0	0
1993/94	<1	0	0	0	0	0	1	3	0	0	0			0	0
Mean 1987/88 to 90/91	<1	0	0	25	0	7	0	21	2	1	0	1	11	<1	0
Mean 1991/92 to 92/93	0	<1	0	1	0	5	1	3	<1	0	0	1	8	0	0

Reporting rates from external tags:

Estimates based on more than 10 tag returns are shown in bold type.

Faroes: 0.75 in 1981/82-1990/91; 1.00 in 1991/92-1992/93
Scotland (N. Esk and Montrose Bay): 1.0
Norway: 0.50
Sweden: 0.65
Elsewhere: 0.50

Table 4.1.6.2 Recaptures in 1993 and 1994 of salmon tagged and released into the open sea at Faroes during the 1992/93 and 1993/94 fishing seasons.

	Tagged 1992/1993 season		Tagged 1993/1994 season	Totals	
Country	Recaptured 1993	Recaptured 1994	Recaptured 1994	Total no recaptured	%
Norway	30	3	4	37	56.1
Scotland	8		1	9	13.6
Ireland	3		2	5	7.6
Russia	1	1	3	5	7.6
Sweden	3	1		4	6.1
Denmark	2			2	3.0
England	1			1	1.5
Iceland	1			1	1.5
Spain	1			1	1.5
Canada	1			1	1.5
Total	51	5	10	66	

Table 4.2.1.1 Numbers of gear units licensed or authorised by country and gear type.

Year	UK (England and Wales)				UK (Scotland)		UK (N. Ireland)				Norway			
	Gillnet licences	Sweepnet	Hand-held net	Fixed engine	Fixed engine[1]	Net and coble	Driftnet	Draftnet	Bagnets and boxes	Rod licences	Bagnet	Bendnet	Liftnet	Driftnet (No. Nets)
1966					11,750	859					7,101		55	
1967					12,697	833					7,106	2,827	48	11,498
1968					12,561	966					6,588	2,613	36	9,149
1969					12,306	847	139	311	17		6,012	2,756	32	8,956
1970					11,097	772	138	306	17		5,476	2,548	32	7,932
1971					10,105	800	142	305	18		4,608	2,421	26	8,976
1972					10,995	806	130	307	18		4,215	2,367	24	13,448
1973					9,646	882	130	303	20		4,047	2,996	32	18,616
1974					14,332	773	129	307	18		3,382	3,342	29	14,078
1975					13,520	764	127	314	20		3,150	3,549	25	15,968
1976					10,814	746	126	287	18		2,569	3,890	22	17,794
1977					14,502	971	126	293	19		2,680	4,047	26	30,201
1978					11,358	686	126	284	18		1,980	3,976	12	23,301
1979					12,862	742	126	274	20		1,835	5,001	17	23,989
1980					12,074	666	125	258	20		2,118	4,922	20	25,652
1981					11,750	652	123	239	19		2,060	5,546	19	24,081
1982					8,385	644	123	221	18	14,784	1,843	5,217	27	22,520
1983	232	209	333	149	10,605	664	120	207	17	14,145	1,735	5,428	21	21,813
1984	226	223	354	149	7,711	634	121	192	19	13,529	1,697	5,386	35	21,210
1985	223	230	375	144	5,775	529	122	168	19	15,209	1,726	5,848	34	20,329
1986	220	221	368	139	4,788	590	121	148	18	15,332	1,630	5,979	14	17,945
1987	213	206	352	143	6,243	574	120	119	18	-	1,422	6,060	13	17,234
1988	210	212	284	145	2,115	393	115	113	18	18,012	1,322	5,702	11	15,532
1989	201	199	282	150	1,837	353	117	108	19	-	1,888	4,100	16	0
1990	200	204	292	144	2,232	338	114	106	17	-	2,375	3,890	7	0
1991	199	187	264	142	1,836	295	118	102	18	-	2,343	3,628	8	0
1992	203	158	267	141	1,799	292	121	91	19	-	2,268	3,342	5	0
1993	187	151	259	89	1,847	264	120	73	18	-	n/a	n/a	n/a	0
1994	177	158	257	81	n/a	n/a	119	68	18	-	n/a	n/a	n/a	0

[1]Annually (number of fixed engine counted together from February to September).

Continued...

Table 4.2.1.1 (cont'd) Numbers of gear units licensed or authorised by country and gear type.

	Ireland				Finland				France		
					The Teno River			R.Näätämö			
	Driftnets No.	Draftnets	Other nets	Rod	Recreational fishery		Commercial fishery	Recreational fishery	Rod and line licences	Com. nets in freshwater[3]	Licences in estuary[3,4]
Year					Fishing days	Fishermen	Fishermen	Fishermen			
1966	510	742	214	11,621							
1967	531	732	223	10,457							
1968	505	681	219	9,615							
1969	669	665	220	10,450							
1970	817	667	241	11,181							
1971	916	697	213	10,566							
1972	1,156	678	197	9,612							
1973	1,112	713	224	11,660							
1974	1,048	681	211	12,845							
1975	1,046	672	212	13,142							
1976	1,047	677	225	14,139							
1977	997	650	211	11,721							
1978	1,007	608	209	13,327							
1979	924	587	240	12,726							
1980	959	601	195	15,864							
1981	878	601	195	15,519	16,859	5,742	677	467			
1982	830	560	192	15,697	19,690	7,002	693	484	4,145	55	82
1983	801	526	190	16,737	20,363	7,053	740	587	3,856	49	82
1984	819	515	194	14,878	21,149	7,665	737	677	3,911	42	82
1985	827	526	190	15,929	21,742	7,575	740	866	4,443	40	82
1986	768	507	183	17,977	21,482	7,404	702	691	5,919[1]	58[1]	86
1987[1]	-	-	-	-	22,487	7,759	754	689	5,804[2]	87[2]	80
1988	836	-	-	11,539	21,708	7,755	741	538	4,413	101	76
1989	801	-	-	16,484	24,118	8,681	742	696	3,826	83	78
1990	756	525	189	15,395	19,596	7,677	728	614	2,977	71	76
1991	707	504	182	15,178	22,922	8,286	734	718	2,760	78	71
1992	691	535	183	20,263	26,748	9,058	749	875	2,160	57	71
1993	673	497	161	23,875	29,461	10,198	755	705	2,111	53	55
1994	732	519	176	24,488	26,517	8,985	751	671	1,680	17	59

[1] Common licence for salmon and seatrout.
[2] Introduction of quotas/fisherman, obligation to declare the catches.
[3] The number of licences indicates only the number of fishermen (or boats allowed to fish for salmon. It overestimates the actual number of fishermen fishing for salmon up to 2 or 3 times.
[4] Adour estuary only southwest of France).
[5] Incomplete figures for 1993

Table 4.2.2.1 CPUE for salmon rod fisheries in Finland (1974-94), France (1987-94) and on the River Bush (UK(N.Ireland))

	Finland (Teno River)				France		UK(N.Ire.) (R.Bush)	
	Catch per angler season		Catch per angler day		Catch per angler season		Catch per rod day	
Year	kg	5 yr mean	kg	5 yr mean	Number	5 yr mean	Number	5 yr mean
1974			2.8					
1975			2.7					
1976			-					
1977			1.4					
1978			1.1					
1979			0.9					
1980			1.1					
1981	3.2		1.2	1.1				
1982	3.4		1.1					
1983	3.4		1.2				0.248	
1984	2.2		0.8				0.083	
1985	2.7		0.9				0.283	
1986	2.1	2.2	0.7	0.8			0.274	0.200
1987	2.3		0.8		0.39		0.194	
1988	1.9		0.7		0.73		0.165	
1989	2.2		0.8		0.55		0.135	
1990	2.8		1.1		0.71		0.247	
1991	3.4	3.4	1.2	1.2	0.60	0.74	0.396	0.275
1992	4.5		1.5		0.94		0.258	
1993	3.9		1.3		0.88		0.341	
1994	2.4		0.8		2.31		0.205	

Table 4.2.2.2 CPUE data for net and fixed engine salmon fisheries by National River Authority Region in UK (England and Wales), 1988-1994.

Data expressed as catch per licence-day.

NRA Region	1988	1989	1990	1991	1992	1993	1994
Northumbria	6.85	5.38	6.64	3.98	3.48	7.26	7.62
Yorkshire	2.24	2.16	2.94	1.28	0.80	3.39	5.63
Southern	10.15	16.8	8.56	6.40	5.0	-	-
Welsh	-	0.90	0.78	0.62	0.69	0.68	1.02
North West	-	0.82	0.63	0.51	0.40	0.63	0.71

Table 4.2.2.3 CPUE data for Scottish net fisheries. Catch in numbers of fish per unit of effort.

Year	Net and Coble	Fixed engines
	Catch/crew month	Catch/trap month [1]
1952	156.87	33.94
1953	122.09	33.16
1954	162.67	29.34
1955	202.53	37.11
1956	117.48	25.72
1957	178.70	32.60
1958	170.39	48.37
1959	159.34	33.32
1960	177.97	30.68
1961	155.34	31.02
1962	182.86	44.29
1964	247.11	57.94
1965	189.20	43.73
1966	211.08	44.92
1967	330.99	72.69
1968	199.29	47.07
1969	328.42	65.58
1970	242.85	50.42
1971	232.19	57.26
1972	249.28	57.62
1973	241.14	73.93
1974	258.44	63.62
1975	236.94	53.76
1976	152.81	43.04
1977	190.35	45.70
1978	197.50	54.10
1979	158.25	42.31
1980	159.57	37.80
1981	182.45	49.53
1982	181.05	62.02
1983	205.28	56.02
1984	159.97	58.70
1985	155.66	54.27
1986	202.44	75.70
1987	146.37	66.18
1988	202.97	51.74
1989	264.21	71.44
1990	146.61	33.21
1991	104.19	35.87
1992	154.07	59.65
1993	125.00	52.69

[1] - Excludes catch and effort data for Splway Region

Table 4.2.4.1 Estimated catches (in tonnes round fresh weight) of wild, farmed and ranched salmon in national catches in the North East Atlantic.

Country	Catches of Salmon						
	Year/ Season	Wild	Farmed		Total Farmed	Ranched	Total
Norway	1989	707.0	FW	29			
			SEA	166	195	3	905
	1990	709.8	FW	29			
			SEA	185	214	6.2	930
	1991	682.5	FW	20			
			SEA	169	189	5.5	877
	1992	653.7	FW	27			
			SEA	176	203	10.3	867
	1993	707	FW	18			
			SEA	191	209	7	923
	1994[2]	758	FW	14			
			SEA	155	169	10	937
Faroes	1990/1991	117.2			84.8	0	202
	1991/1992	20.4			10.6	0	31
	1992/1993	16.1			5.9	0	22
	1993/1994	5.8			1.2	0	7
Finland	1991	68			<1	0	69
	1992	77			<1	0	78
	1993	70			<1	0	70
	1994	49			<1	0	49
France	1991	13			0	0	13
	1992	20			0	0	20
	1993	16			0	0	16
	1994	18			0	0	18
Iceland	1991	130			3	375	505
	1992	175.5			+	412	590
	1993	160			-	496	656
	1994	140			-	308	448
Ireland[4]	1991	399.7			1.7	1.4	404
	1992	619			3.5	7.2	630
	1993	537.4			1.2	4.3	543
	1994	809.5			2.6	6.9	819
Russia	1991	215			0	0	215
	1992	166			0	0	166
	1993	140			0	0	140
	1994	138			0	0	138
Sweden	1991	23			1	14[1]	38
	1992	24			1	24[1]	49
	1993	35			1	20[1]	56
	1994	15			1	29[1]	45
UK (E&W)	1991	200			0	0	200
	1992	186			0	0	186
	1993	274			0	0	274
	1994	319			0	0	319
UK (N.Ire)	1991	54			<1	-	55
	1992	85.3			1.1	2.6	89
	1993	80.5			0.2	2.3	83
	1994[2]	90.1			0.5	0.35	91
UK (Scot)	1991	448			14	0	462
	1992	569			31	0	600
	1993	515			31	0	546
	1994[2,3]	593			3	0	596

[1] Fish released for mitigation purposes and not expected to contribute to spawning.
[2] Provisional figures.
[3] 1994 data as reported in catch statistics; previous years' data calculated from sampling programmes.
[4] Smolts released for enhancement of stocks or rod fisheries are included in wild.

Table 4.2.4.2 Proportion of farmed Atlantic salmon (unweighted means) in marine fisheries in Norway 1989-1994. n=number of salmon examined.

	Coast				Fjords			
Year	**n**	**No.localities**	**%**	**Range**	**n**	**No.localities**	**%**	**Range**
1989	1217	7	45	7 - 66	803	4	14	8 - 29
1990	2481	9	48	16 - 64	940	5	15	6 - 36
1991	1245	6	49	29 - 63	336	3	10	6 - 16
1992	1162	7	44	4 - 72	307	1	21	-
1993	1477	7	47	1 - 60	520	4	20	7 - 47
1994	1087	7	34	2 - 62	615	4	19	2 - 42

Table 4.2.4.3 Proportion of farmed Atlantic salmon (unweighted means) in rod catches (1 June-18 August) and brood stock catches (18 August–30 November) in 1989–1994. n=number of salmon examined. R= number of rivers sampled.

	1 June–18 August				18 August–30 November			
Year	**n**	**R**	**%**	**Range**	**n**	**R**	**%**	**Range**
1989	5744	39	7	0 - 26	1791	16	38	2 - 77
1990	5380	39	7	0 - 55	2004	21	33	2 - 82
1991	3707	27	5	0 - 23	1563	22	25	0 - 82
1992	4034	31	5	0 - 24	1394	19	27	0 - 71
1993	2314	20	4	0 - 22	1032	16	21	0 - 64
1994	2414	14	5	0 - 19	1602	16	21	0 - 61

Table 4.2.4.4 Salmon farm escapees identified during microtag recovery programmes in the Republic of Ireland and Northern Ireland

Sampling	Year	Fishing Area: UK (N.Ireland) TOTAL	Ireland: Denegal	Mayo	Galway Limerick	South West	TOTAL
No. examined	1994	11703	78021	16270	21853	18859	146706
No. escapees		138	106	17	18	203	482
% in sample		1.18	0.14	0.10	0.08	1.08	0.33
Raised to total catch		143	106	73	28	676	883
% examined		*97*	*100*	*23*	*64*	*30*	*50*
No. examined	1993	6092	62291	29801	17298	1425	116907
No. escapees		16	53	81	11	15	176
% in sample		0.26	0.09	0.27	0.06	1.05	0.15
Raised to total catch		28	18	151	13	180	390
% examined		*57*	*100*	*53*	*78*	*4*	*55*
No. examined	1992	6018	73828	23787	9771	7119	120523
No. escapees		224	18	403	10	1	656
% in sample		3.72	0.02	1.69	0.1	0.01	0.54
Raised to total catch		425	18	713	20	6	1182
% examined		*53*	*100*	*33*	*33*	*17*	*49*
No. examined	1991	n/a	59891	29245	3853	5621	98610
No. escapees		n/a	0	338	15	0	353
% in sample		n/a	0	1.16	0.39	0	0.36
Raised to total catch		n/a	0	524	38	0	562
% examined			*100*	*64*	*29*	*23*	*73*

n/a = not available

Table 4.2.4.5 Salmon farm escapees in R. Bush based on operation of total trap throughout the year.
(Note 1994 data includes 14 escapees entering in January 1995)

YEAR	1991	1992	1993	1994
Total run (excl. ranched)	2344	2570	3253	1952
No. escapees	3	24	18	54
% in sample	0.13	0.93	0.55	2.77

Table 4.2.5.1 Estimated exploitation rates (in %) of salmon in homewater fisheries in the North East Atlantic area (Ireland and UK)

Year	Ireland[1] Burrishoole Total HR 1SW	UK (England + Wales)[2] Dee rod W (all ages)	UK (England + Wales)[2] Itchen net W (all ages)	UK (England + Wales)[2] Itchen rod W (all ages)	UK (England + Wales)[2] Test rod W (all ages)	UK (Northern Ireland)[1] River Bush net W 1SW	UK (Northern Ireland)[1] River Bush net W/HR 2SW	UK (Northern Ireland)[1] River Bush net HR1+ 1SW	UK (Northern Ireland)[1] River Bush net HR2+ 1SW	UK (Scotland)[2] North Esk In-river netting W 1SW	UK (Scotland)[2] North Esk In-river netting W 2SW
1985	86							93	-	23	35
1986	86							82	75	40	29
1987	78					69	46	94	77	29	37
1988	75				39	65	36	72	57	35	37
1989	82		9	45	29	89	60	92	83	25	26
1990	52	6	20	51	36	61	38	63	70	37	37
1991	65	16	30	45	26	65	43	57	46	10	15
1992	71	14	0	27	25	56	33	74	75	28	27
1993	71	12	0	42	28	41	12	67	71	25	19
1994[3]	76	17	0	50	32	-	36	71	64	19	25
Mean 1989-93	68	10	12	42	29	78	37	71	69	25	25

[1] Estimate based on microtag recoveries raised to total catch and including estimate of non-catch fishing mortality.
[2] Estimate based on counter and catch figures.
[3] Provisional figures.
[4] Probably underestimated.
HR = Hatchery reared.
W = Wild.

Continued..........

Table 4.2.5.1 (cont'd) Estimated exploitation rates (in %) of salmon in homewater fisheries in the North East Atlantic area (Iceland, Norway, Sweden and Russia)

	Iceland[1]	Norway[2]						Sweden[3]		Russia[1,6]		
	Ellidaar	Drammen		Imsa				Lagan		Ponoy	Kola	Tuloma
Year	W	HR[4]		W		HR4		HR2+		W	W+HR	W
	1SW	1SW	2SW	1SW	2SW	1SW	2SW	1SW	2SW	all sea ages		
1985	40	57	-	73	94	81	100	81		47	90	47
1986	34	81	50	79	82	78	90	93	82	50	77	50
1987	54	64	52	56	95	83	95	78	55	48	91	49
1988	45	70	47	51	80	78	91	73	91	77	87	51
1989	41	40	59	65	74	44	65	76	86	78	84	50
1990	44	23	40	42	42	47	68	80	82	50	80	50
1991	37	54	59	37	72	50	66	91	92	20	58	48
1992	48	-	51	61	76	74	91	73	98	11	77	45
1993	41	20	-	53	80	85	89	89	82	10	79	39
1994[5]	49	41	33	55	80	66	94	53	100	0	73	42
Mean												
1989–93	43	34	52	52	69	60	76	79	89	34	76	46

[1]Estimate based on counter and catch figures.
[2]Estimates based on external tag recoveries and counter figures.
[3]Estimate based on external tag recoveries and on assumed 50% exploitation in the river brood stock fishery
[4]HR in R. Drammen and R. Imsa are pooled groups of 1+ and 2+ smolts.
[5]Provisional figures.
[6]Net only.
W = Wild
HR = Hatchery reared.

Reporting rates for external tags:

N. Esk	1
Montrose Bay	1
Norway	0.5
Sweden	0.65
Elsewhere	0.5

Table 4.3.1.1 Estimated numbers of spawners and egg deposition and fraction of target attained in rivers in the North East Atlantic area

Year	Spawners		eggs	Target attainment		
	1SW	MSW	(million)	1SW/target	MSW/target	eggs/target
FRANCE		**River Scorff**				
Target:			**2.16**			
Observed:						
1994	499	88	1.43	-	-	0.66
IRELAND		**River Burrishoole**				
Target:	**616**		**1.29**			
Observed:						
1980	832		1.75	1.35		1.36
1981	348		0.73	0.56		0.57
1982	510		1.07	0.83		0.83
1983	602		1.26	0.98		0.98
1984	319		0.67	0.52		0.52
1985	567		1.19	0.92		0.92
1986	495		1.04	0.80		0.81
1987	468		0.98	0.76		0.76
1988	458		0.96	0.74		0.74
1989	662		1.39	1.07		1.08
1990	231		0.49	0.38		0.38
1991	547		1.15	0.89		0.89
1992	360		0.76	0.58		0.59
1993	528		1.11	0.86		0.86
1994	516		1.08	0.84		0.84
RUSSIA		**River Tuloma**				
Target:	**830**	**3530**	**42.19**			
Observed:						
1982	320	535	5.41	0.39	0.15	0.13
1983	330	1956	20.89	0.40	0.55	0.50
1984	573	1996	26.10	0.69	0.57	0.62
1985	412	1665	17.90	0.50	0.47	0.42
1986	235	1010	13.40	0.28	0.29	0.32
1987	210	803	8.43	0.25	0.23	0.20
1988	168	669	6.41	0.20	0.19	0.15
1989	255	1251	12.21	0.31	0.35	0.29
1990	276	1691	14.47	0.33	0.48	0.34
1991	470	2265	21.50	0.57	0.64	0.51
1992	142	1222	21.40	0.17	0.35	0.51
1993	200	1207	12.04	0.24	0.34	0.29

Table 4.3.1.1 (cont'd) Estimated numbers of spawners and egg deposition and fraction of target attained in rivers in the North East Atlantic area

Year	Spawners		eggs	Target attainment		
	1SW	MSW	(million)	1SW/target	MSW/target	eggs/target
UK(ENG. & WALES)	**River Dee**					
Target:	**3439**	**3647**	**24.64**			
Observed:						
1992	2479	1157	11.15	0.72	0.32	0.45
1993	6459	1479	23.59	1.88	0.41	0.96
1994	3127	875	11.90	0.91	0.24	0.48
UK(N.IRELAND)	**River Bush**					
TARGET			**2.31**			
Observed						
1985			3.53			1.53
1986			4.79			2.07
1987			3.43			1.48
1988			4.60			1.99
1989			1.06			0.46
1990			2.44			1.06
1991			2.97			1.29
1992			2.57			1.11
1993			3.00			1.30
1994			2.25			0.97
UK(SCOTLAND	**North Esk**					
Target:	**2334**	**1658**	**12.78**			
Observed:						
1981	4975	3773	35.23	2.13	2.28	2.76
1982	5251	2495	26.96	2.25	1.50	2.11
1983	5800	2654	30.00	2.49	1.60	2.35
1984	4635	1962	21.69	1.99	1.18	1.70
1985	5548	3488	40.13	2.38	2.10	3.14
1986	3609	2717	26.45	1.55	1.64	2.07
1987	4409	1966	24.20	1.89	1.19	1.89
1988	7638	2575	31.56	3.27	1.55	2.47
1989	7234	2981	36.97	3.10	1.80	2.89
1990	2334	1658	12.78	1.00	1.00	1.00
1991	5785	2561	29.15	2.48	1.54	2.28
1992	7370	2334	38.32	3.16	1.41	3.00
1993	5426	4288	33.77	2.32	2.59	2.64
1994	-		-	-	-	-

Table 4.3.2.1 Wild smolt counts and estimates, and juvenile survey data on various index streams in the North East Atlantic (Finland, Norway and Sweden)

Year of Count	Finland							Norway		Sweden
	River Teno	River[1] Inarijoki	River[1] Utsjoki	River[2] Ylapulmankijoki	River[2] Tsarsjoki	River[2] Karigssjoki	River[2] Kuoppilssjoki	River Imsa	River Orkla	River Hogvadsån
	Juvenile Survey[3]	Juvenile Survey[3]	Juvenile Survey[3]	Smolt Total Trap	Smolt Total Trap	Smolt Total Trap	Smolt Total Trap	Smolt Total Count	Smolt Estimate	Smolt Partial Count[4]
1964										9,771
1965										2,610
1966										367
1967										627
1968										1,564
1969										4,742
1970										242
1971										-
1972										-
1973										1,184
1974										184
1975										363
1976										247
1977										-
1978										38
1979	19.9	18.0	93.2							103
1980	26.4	37.2	46.2							1,064
1981	13.4[5]	17.9	52.3					3,214		500
1982	36.6	19.7	70.5					736		1,566
1983	53.4	51.8	86.5					1,287	121,000	2,982
1984	39.1	40.6	70.7					936	183,000	4,961
1985	60.8	40.8	84.2					892	173,000	4,989
1986	52.0	40.5	41.5					477	227,000	2,076
1987	45.1	45.5	70.8					480	238,000	3,173
1988	33.4	46.2	49.0					1,700	152,000	2,571
1989	36.1	37.9	81.3	2,500	2,495			1,194	-	882
1990	35.3	51.1	101.5	3,058	2,615	2,576		1,822	323,000	1,042
1991	40.7	53.2	32.3	2,447	1,828	1,349	739	1,995	243,000	1,235
1992	25.8[5]	48.2	51.2	3,538	4,219	435	257	1,500	262,534	1,247
1993	34.0	41.5	66.7	2,825	3,078	189[5]	70	398	297,264	1,305
1994	-	-	-	1,268	2,794	706	142	34	165,875	1,048
Mean	36.8	39.3	66.5	2,608	2,838	1,051	302	1,194	216,879	2,245

[1] Major tributary of River Teno
[2] Tributary of River Teno
[3] Juvenile survey represents mean fry and parr abundance (number 100 m^2 caught by electrofishing) at 35, 10 and 12 sites respectively.
[4] Smolt trap catch represents part of the run.
[5] Incomplete data. Minimum numbers due to high water levels.

Continued.....

Table 4.3.2.1 (Cont'd) Wild smolt counts and estimates, and juvenile survey data on various index streams in the North East Atlantic (Iceland, France, Ireland, UK(N.Ireland), UK(Scotland)

Year of Count	Iceland		France			Ireland	UK (N Ireland)		UK (Scotland)	
	River Ellidaar	River Vesturdalsa	River Nivelle	River Oir	River Bresle	River Burrishoole	River Bush		River North Esk	Girnock Burn
	Smolt Estimate	Smolt Estimate	Juvenile Survey[6]	Smolt Estimate	Smolt Estimate	Smolt Total trap	Smolt Total Trap	Juvenile Survey[7]	Smolt Estimate	Smolt Total trap
1964									275,000	
1965									183,000	
1966									172,000	
1967									98,000	2,057
1968									227,000	1,440
1969									-	2,610
1970									-	2,412
1971									167,000	2,461
1972									260,000	2,830
1973									165,000	1,812
1974							43,958		106,000	2,842
1975							33,365		173,000	2,444
1976							21,021		93,000	2,762
1977							19,693		-	3,679
1978							27,104		-	3,149
1979							24,733		-	2,724
1980						11,208	20,139		132,000	3,074
1981						9,434	14,509		195,000	1,640
1982					1,860	10,381	10,694		160,000	1,626
1983					1,880	9,383	26,804	32.6	-	1,747
1984					1,250	7,270	30,009[8]	19.5	225,000	3,247
1985	29,000		850	529	2,550	6,268	30,518[8]	7.6	130,000	2,716
1986	-		6,500	1,325	1,245	5,376	18,442	11.3	-	2,091
1987	-		11,800[9]	379	-	3,817	21,994	10.3	199,000	1,132
1988	23,000		9,950[9]	454	-	6,554	22,783	8.9	-	2,595
1989	22,500	14,642	6,658	858	-	6,563	17,644	16.2	141,000	1,360
1990	24,000	11,115	2,505[9]	817	-	5,968	17,133	5.6	175,000	2,042
1991	22,000	9,300	5,287	210	-	3,804	18,218	12.5	236,000	1,503
1992	27,700	19,100	3,452	678	690	6,926	10,021	13.0	-	2,572
1993	18,000	-[11]	2,640	233	810	5,429	11,583[10]	7.8	-	2,147
1994	-	-[11]	-	647	1,870	5,971	14,145	11.5	148,000	1,223
Mean	23,743	12,879	5,516	613	1,519	6,945	21,643	13.1	174,300	2,283

[6] Estimate of 0+ parr population size in autumn.
[7] Juvenile surveys represent index of fry (0+) abundance (number per 5 minutes electrofishing) at 137 sites, based on natural spawning in the previous year.
[8] These smolt counts show effects of enhancement.
[9] Influenced by enhancement (fry releases).
[10] Minimum estimate due to severe flooding.
[11] Smolt counts too small for estimate.

Table 4.3.2.2 Status of stocks in the North East Atlantic, summary of trend analyses based on non-parametric method (1000 iterations)

Type of data	Test No.	Rivers (Countries)	Life stage	Period of time	p value	Trend
Section 4.3.2 Smolt counts	1.	Oir (Fra), Imsa + Orkla (Nor), Burrishoole (Irl), Bush (UK NI), North Esk + Girnock (UK Scot),	Smolts	11	>0.1	Nt
	2.	Oir (Fra), Imsa + Orkla (Nor), Burrishoole (Irl), Bush (UK(NI)), North Esk + Girnock (UK Scot), Ellidaar + Versturdalsa (Ice), Hogvadsan (Swe), Ylapulmankijoki +Tsarsjoki (Fin)	Smolts	6	>0.1	Nt
Section 4.3.3 Adult counts:	3.	Burrishoole (Irl), Severn (UK E&W), North Esk + Girnock (UK Scot), Bush, Mourne + Faughan (UK NI), Imsa (Nor)	Adults	11	0.01	**Up**
W. Europe & Scandinavia	4.	Burrishoole (Irl), Severn + Usk (UK E&W), North Esk + Girnock (UK Scot), Bush, Mourne + Faughan (UK NI), Imsa (Nor), Ellidaar (Ice), Hogvadsan (Swe)		6	0.015	**Up**
Adult counts: Russia	5.	Tuloma, Ponoy, Kola, Zap Litca	Adults	31	0	**Up**
	6.	Tuloma, Ponoy, Kola, Zap Litca		21	>0.1	Nt
	7.	Tuloma, Ponoy, Kola, Zap Litca		11	>0.1	Nt
	8.	Tuloma, Ponoy, Kola, Zap Litca, Varzuga, Keret, Yokanga	Adults	6	>0.1	Nt
Section 4.3.4 Wild	9.	Bush (UK NI), Imsa + Figgio (Nor), North Esk (UK Scot)	1SW return to homewaters	11	0.03	**Down**
smolt survival:	10.	Bush (UK NI), Imsa + Figgio (Nor), North Esk (UK Scot), Elidaar (Ice)	1SW return to homewaters	6	>0.1	Nt
	12.	Imsa (Nor), North Esk (UK Scot), Figgio (Nor)	2SW return to homewaters	11	0.03	**Down**
	13.	Imsa (Nor), North Esk (UK Scot), Figgio (Nor)	2SW return to homewaters	6	>0.1	Nt
	14.	Bush (UK NI), Imsa (Nor), North Esk (UK Scot), Burrishoole (Irl)	1SW return to freshwater	11	0.012	**Up**
	15.	Bush (UK NI), Imsa (Nor), North Esk (UK Scot), Burrishoole (Irl), Elidaar (Ice)	1SW return to freshwater	6	0.01	**Up**
	16.	Imsa (Nor), North Esk (UK Scot), Bush (UK NI)	2SW return to freshwater	11	>0.1	Nt
	17.	Imsa (Nor), North Esk (UK Scot), Bush (UK NI)	2SW return to freshwater	6	>0.1	Nt
Section 4.3.4 Hatchery	18.	Kollafjordur (Ice), Burrishoole (Irl), Bush (UK NI), Imsa and Drammen (Nor), Lagan (Swe)	1SW return to homewaters	11	0.01	**Down**
smolt survival:	19.	Kollafjordur (Ice), Burrishoole (Irl), Bush (UK NI), Imsa and Drammen (Nor), Lagan (Swe)	1SW return to homewaters	6	>0.1	Nt
	20.	Kollafjordur (Ice), , Imsa + Drammen (Nor), Lagan (Swe)	2SW return to homewaters	11	0.1	**Down**
	21.	Kollafjordur (Ice), Imsa + Drammen (Nor), Lagan (Swe)	2SW return to homewaters	6	>0.1	Nt
	22.	Burrishoole (Ir), Bush (UK NI), Imsa + Drammen (Nor), Kollafjordur (Ice)	1SW return to freshwater	11	>0.1	Nt
	23.	Burrishoole (Ir), Bush (UK NI), Imsa + Drammen (Nor), Kollafjordur (Ice)	1SW return to freshwater	6	>0.1	Nt
	24.	Imsa + Drammen (Nor), Kollafjordur (Ice)	2SW return to freshwater	11	0.1	**Down**
	25.	Imsa + Drammen (Nor), Kollafjordur (Ice)	2SW return to freshwater	6	>0.1	Nt

Time period: 6 = last six years
11 = last 11 years

Trends: Up = significant increase
Down = significant decrease
Nt = no trend

Table 4.3.3.1 Wild adult counts to various rivers in the North East Atlantic area. (Scandinavia and Russia)

Year	Iceland River Ellidaar Estimate	Norway River Imsa Total trap	Sweden River Högvadsån Total trap	Russia River Tuloma Total trap	Russia River Varzuga Total trap	Russia River Keret Total trap	Russia River Ponoy Total trap	Russia River Kola Total trap	Russia River Yokanga Total trap	Russia R. Zap. Litca Total trap
1952				4800						
1953				2950						
1954			364	4010						
1955			210	4600				4855		
1956			144	4800				2176		
1957			126	4300				2949		
1958			632	6228				1771		1051
1959			197	6125				2790		1642
1960			209	10360				5030		2915
1961			229	11050				5121		2091
1962			385	10920				5776		2196
1963			217	7880				3656		1983
1964			390	4400			23666	3268		1664
1965			442	5600			12998	3676		1506
1966			375	3648			10333	3218		787
1967			90	9011			11527	7170		1486
1968			172	6277			18352	5008		1971
1969			321	4538			9267	6525		2341
1970			610	6175			9822	5416		2048
1971			173	3284			8523	4784		1502
1972			281	6554			10975	8695		1316
1973			100	9726			20553	9780		1319
1974			270	12784			24652	15419		2605
1975			138	11074			41666	12793		2456
1976			65	8060			44283	9360		1325
1977			49	2878			37159	7180		1595
1978			23	3742			24045	5525		766
1979			15	2887			17920	6281		700
1980			260	4087			15069	7265		548
1981			512	3467			11670	7131		477
1982		66	572	4252			9585	5898		889
1983		14	447	9102			15594	10643		1254
1984		32	629	10971			26330	10970		1859
1985		31	768	8067			38787	6163		1563
1986	2726	22	1632	7275	71562	2798	32266	6508	3212	1815
1987		9	1475	5470	137419	1986	21212	6300	3468	1498
1988		44	1283	8069	72528	2898	20620	5203	2270	575
1989	2921	83	480	8413	65524	2986	19214	10929	2850	2613
1990	1822	67	879	11594	56000	2520	37712	13383	3376	1194
1991	1881	43	534	7174	63000	690	21000	8500	1704	2081
1992	2917	70	345	5476	61300	-	26600	14670	5531	2755
1993	2578	39	60	4520	68300	1062	26800	11400	3200	2267
1994	1894	30	640	3320	77802	n/a	20500	9730	2850	2100
Mean	2396	42	408	6510	74826	2134	21571	6998	3136	1642

Continued....

Table 4.3.3.1 Cont'd) Wild adult counts to various rivers in the NE Atlantic area. (Ireland, UK and France)

Year	Ireland	UK (E&W)	UK (E&W)	UK (NI)	UK(NI)	UK(NI)	UK(Scotl.)	UK(Scotl.)	France	France	France
	R.Burrishoole	R. Severn	R. Usk	R. Bush	R.Faughan	R. Mourne	R.N. Esk	Girnock	R. Nivelle	R. Oir	R. Bresle
	Total trap	Counter	Counter	Total trap	Counter	Counter	Counter	Total trap	Trap est.	Trap est.	Trap est.
1966					6792	15112		269			
1967					1723	7087		214			
1968					1657	2147		196			
1969					1195	1569		49			
1970					3214	5050		90			
1971					1758	4401		125			
1972					1020	1453		137			
1973				2614	1885	2959		225			
1974				3483	2709	3630		184			
1975				3366	1617	1742		121			
1976				3124	2040	2259		164			
1977				1775	2625	2419		115			
1978				1621	2587	5057		38			
1979				1820	3262	2226		82			
1980	832	3416		2863	3288	3146		203			
1981	348	3884		1539	3772	2399	9025	67			
1982	510	1875		1571	2909	4755	8121	73			
1983	602	1232		1030	2410	1271	8972	63			
1984	319	1711		672[1]	2116	1877	7007	106	33	295	98
1985	567	3257		2443	9077	8149	9912	67	61	301	148
1986	495	2129		2930	4915	6295	6987	156	204	204	211
1987	468	1206		2530	907	2322	7014	293	138	128	188
1988	458	1958	7446	2832	3228	7572	11243	187	130	235	89
1989	662	5207	1719	1029	8287	9497	11026	108	263	235	214
1990	231	1006	2532	1850	6458	11541	4762	58	291	121	126
1991	547	1006	1911	2341	4301	7987	9127	97	184	46	211
1992	360	1388	3084	2546	7375	7420	10795	73	240	45	243
1993	528	1048	5197	3235	8655	17855	10887	42	472	161	74
1994	516	1894	9130	2010	7439	19908	11341	81	263	99	77
Mean	496	2149	3648	2237	3767	5381	9016	127	203	174	152

[1]Minimum count.

In the UK(E&W) Severn the counter is some distance upstream so that the counts do not represent total counts for this systems. In the UK(Scotl.)Girnock, the trap is located in the Girnock Burn, a tributary in the upper reaches of the River Dee (Aberdeenshire). In the UK(Scotl.) N. Esk, counts are recorded upstream of the in-river commercial fishery and most important angling fishery. Thus, the counts do not necssarily reflect the numbers of fish entering the river.

Table 4.3.4.1 Estimated survival of wild smolts (%) to return to homewaters (prior to coastal fisheries) for various monitored rivers in the NE Atlantic area.

Smolt	Iceland[1]			UK (N.Ireland)	Norway[2]		UK (Scotland)[2]			France		
migration	Ellidaar	R.Vesturdalsa[4]		R. Bush	R. Imsa		North Esk			Oir[5]	Nivelle[6]	Bresle
year	1SW	1SW	2SW	1SW[3]	1SW	2SW	1SW	2SW	3SW	All ages	All ages.	All ages
1975	20.0											
....												
1981					17.3	4.0	13.7	6.9	0.3			
1982					5.3	1.2	12.6	5.4	0.2			
1983		2.0			13.5	1.3	-	-	-	3.2		8.5
1984					12.1	1.8	10.0	4.1	0.1	7.7		16.3
1985	9.4				10.2	2.1	26.1	6.4	0.2	7.5		12.2
1986				31.3	3.8	4.2	-	-	-	3.9	15.8	19.4
1987				35.1	17.3	5.6	13.9	3.4	0.1	9.3	2.6	-
1988	12.7			36.2	13.3	1.1	-	-	-	2.3	2.4	-
1989	8.1	1.1	2.0	25.0	8.7	2.2	7.8	4.9	0.1	2.4	3.5	-
1990	5.4	1.0	1.0	34.7	3.0	1.3	7.3	3.1	0.2	6.1	1.8	-
1991	8.8	4.2	0.6	27.8	8.7	1.2	11.2	4.5	-	13.2	9.2	-
1992	9.6	2.4	0.8	29.0	6.7	0.9	-	-	-	4.9[7]	8.8[7]	10.2[7]
1993	9.8	-		-	15.6	-	-	-	-	14.5[7]	6.6[7]	13.8[7]

[1] Microtags.
[2] Carlin tags, not corrected for tagging mortality.
[3] Microtags, corrected for tagging mortality.
[4] Assumes 50% exploitation in rod fishery.
[5] Minimum estimates.
[6] From 0+ stage in autumn.
[7] Incomplete returns.

Table 4.3.4.2. Estimated survival of wild smolts (%) into freshwater for various monitored rivers in the NE Atlantic area.

Smolt year	Iceland[1]			Ireland	UK(N.Ireland)		Norway[2]		UK (Scotland)[1]			France		
	River Ellidaar	River Vesturdalsa[5]		River Burrishoole	River Bush		River Imsa		North Esk[4]			Oir[3]	Nivelle[6]	Bresle
	1SW	1SW	2SW	1SW	1SW	2SW	1SW	2SW	1SW	2SW	3SW	All ages	All ages	All ages
1975	20.8													
1979	-			7.3										
1980	-			3.1										
1981	-			5.4	9.5	0.9	2.1	0.3	4.2	2.0	0.2			
1982	-			5.8	7.8	0.8	0.7	0.1	4.9	2.2	0.2			
1983	-	2.0		3.4	1.9[3]	1.7	2.4	0.1	-	-	-	3.2		5.5
1984	-	-		7.8	6.4	1.4	3.2	0.3	3.9	2.1	0.1	7.7		11.7
1985	9.4	-		7.9	7.9	1.9	2.1	0.1	5.9	2.9	0.2	7.5		9.6
1986	-	-		8.7	9.7	1.9	1.7	0.8	-	-	-	3.9	15.7	14.4
1987	-	-		12.0	12.0	0.4	8.3	1.5	6.7	2.1	0.1	9.3	2.7	-
1988	12.7	-		10.1	3.9	0.8	4.5	0.6	-	-	-	2.3	2.2	-
1989	8.1	1.1	2.0	3.5	9.3	1.4	4.9	0.6	3.5	2.7	0.1	2.4	3.5	-
1990	5.4	1.0	1.0	9.2	11.8	1.7	1.7	0.3	4.2	2.1	0.2	6.1	1.8	-
1991	8.8	4.2	0.6	9.5	12.0	2.2	3.4	0.2	5.2	2.3	-	13.2	9.2	-
1992	9.6	2.4	0.8	7.6	16.8	2.0	3.1	0.2	--	-	-	4.9[7]	8.8[7]	8.6[7]
1993	9.8	-		9.5	15.1		7.0					14.5[7]	6.6[7]	10.0[7]

[1] Microtags.
[2] Carlin tags, not corrected for tagging mortality.
[3] Minimum estimate.
[4] Before in-river netting.
[5] Assumes 50% exploitation in rod fishery.
[6] Survival of 0+parr to adults.
[7] Incomplete returns.

Table 4.3.4.3 Estimated survival of hatchery smolts (%) to adult return to homewaters, (prior to coastal fisheries) for various monitored rivers and experimental facilities in the NE Atlantic area.

Smolt year	Iceland[1] Kollafjordur		Ireland[1] R.Burri-shoole[3]	R. Shannon		N. Ireland[1] R. Bush (1SW)		Norway[2] R Imsa		R Drammen		Sweden[2] R. Lagan	
	1SW	2SW	1SW	1SW	MSW	1+ smolts	2+ smolts	1SW	2SW	1SW	2SW	1SW	2SW
1981	5.6	3.1	10.5			-	-	10.1	1.3	-	-	-	-
1982	8.7	1.6	9.7			-	-	4.2	0.6	-	-	-	-
1983	1.2	0.9	3.64			1.9	8.1	1.6	0.1	-	-	-	-
1984	4.5	0.5	25.1			13.3	-	3.8	0.4	3.5	3.0	11.8	1.1
1985	7.3	0.7	28.9			15.4	17.5	5.8	1.3	3.4	1.9	11.8	0.9
1986	no release		9.4			2.0	9.7	4.7	0.8	6.1	2.2	7.9	2.5
1987	8.9	0.7	13.6			6.5	19.4	9.8	1.0	1.7	0.7	8.4	2.4
1988	1.0	0.7	17.9			4.9	6.0	9.5	0.7	0.5	0.3	4.3	0.6
1989	1.0	0.5	5.1			8.1	23.2	3.0	0.9	1.9	1.3	5.0	1.3
1990	2.7	0.4	10.5			5.6	5.6	2.8	1.5	0.3	0.4	5.2	3.1
1991	3.2	0.9	8.4	5.4	0.19	5.4	8.8	3.2	0.7	0.1	0.1	3.6	1.1
1992	5.1	-	7.5	3.51	-	6.0	7.8	3.8	0.7	0.3	0.6	1.5	0.4
1993	-	-	10.7	-	-	1.1	5.8	6.5	-	2.9	-	3.2	-

[1]Microtagged.
[2]Carlin tagged, not corrected for tagging mortality.
[3]Return rates to rod fishery with constant effort.

Table 4.3.4.4 Estimated survival of hatchery smolts (%) to adult return to freshwater, for various monitored rivers and experimental facilities in the NE Atlantic area.

	Iceland[1]			Ireland[1]		N. Ireland[1]		Norway[2]				Sweden[2]	
Smolt year	Kollafjordur		R.Burri-shoole[3]	R.Shannon		R. Bush (1SW)		R Imsa		R Drammen		R Lagan	
	1SW	2SW	1SW	1SW	MSW	1+ smolts	2+ smolts	1SW	2SW	1SW	2SW	1SW	2SW
1981	5.6	3.1	1.3			-	-	2.0	0.1				
1982	8.7	1.6	1.7			-	-	0.2	0.03				
1983	1.2	0.9	1.7			0.1	0.4	0.1	0.0				
1984	4.5	0.5	3.4			0.9		0.6	0.03	2.5	1.2		
1985	7.3	0.7	4.0			2.8	4.3	1.3	0.13	0.6	0.9		
1986	no release		2.1			0.1	2.1	1.1	0.07	2.2	1.1		
1987	8.9	0.7	3.4			1.8	8.2	2.1	0.3	0.5	0.3		
1988	1.0	0.7	3.3			0.4	1.0	4.8	0.2	0.3	0.2		
1989	1.0	0.5	2.5			2.9	6.8	1.5	0.3	1.4	0.6		
1990	2.7	0.4	3.7			2.4	3.0	1.3	0.1	0.1	0.2		
1991	3.2	0.9	2.5	1.26	0.1	1.4	2.2	0.8	0.1	-	-		
1992	5.1	0.8	2.2	1.45	-	2.0	2.3	0.6	0.1	0.2	0.4	-	-
1993	2.5	-	3.3	-	-	0.3	2.0	2.2	-	1.7	-	0.8	-

[1]Microtagged.
[2]Carlin tagged, not corrected for tagging mortality.
[3]Return rates to rod fishery with constant effort.

Table 5.1.2.1 Preliminary 1994 catches by recreational (R), native food (N), and commercial (C) fisheries in Canada by province (in kg round fresh weight).

	Small salmon (kg)	Small salmon (%)	Large salmon (kg)	Large salmon (%)	Total (kg)	Total (%)
Quebec						
R	13,593	9.8	62,295	29.2	75,888	21.6
N	667	0.5	27,783	13.0	28,450	8.1
C	7,485	5.4	41,904	19.6	49,389	14.0
Total	21,745	15.7	131,982	61.9	153,727	43.7
Newfoundland						
R	52,483	37.9	1,858	0.9	54,341	15.5
N	0	0.0	0	0.0	0	0.0
C	17,911	12.9	74,225	34.8	92,136	26.2
Total	70,394	50.9	76,083	35.7	146,477	41.7
New Brunswick						
R	38,183	27.6	0	0.0	38,183	10.9
N	5,680	4.1	3,894	1.8	9,574	2.7
C	0	0.0	0	0.0	0	0.0
Total	43,863	31.7	3,894	1.8	47,757	13.6
Nova Scotia						
R	1,948	1.4	0	0.0	1,948	0.6
N	337	0.2	1,330	0.6	1,667	0.5
C	0	0.0	0	0.0	0	0.0
Total	2,285	1.7	1,330	0.6	3,615	1.0
Pr. Edward Isl						
R*	60	0.0	0	0.0	60	0.0
N	0	0.0	0	0.0	0	0.0
C	0	0.0	0	0.0	0	0.0
Total	60	0.0	0	0.0	60	0.0
TOTAL						
R	106,267	76.8	64,153	30.1	170,420	48.5
N	6,684	4.8	33,007	15.5	39,691	11.3
C	25,396	18.4	116,129	54.4	141,525	40.2
Total	138,347	100.0	213,289	100.0	351,636	100.0

R = Recreational
N = Native food
C = Commercial
*Morell River only

Table 5.1.2.2 Nominal catches (tonnes) in Quebec and Newfoundland and Labrador commercial Atlantic salmon fishery, 1971-1994. Catches for 1994 are preliminary.

Year	Small	Large	Total[1]
1974	-	-	2,186
1975	754	1,433	2,187
1976	637	1,528	2,166
1977	537	1,525	2,062
1978	277	1,001	1,277
1979	496	551	1,045
1980	814	1,448	2,261
1981	680	1,351	2,031
1982	580	837	1,418
1983	420	720	1,140
1984	333	537	871
1985	474	512	986
1986	614	716	1,330
1987	710	883	1,593
1988	519	551	1,070
1989	436	511	947
1990	290	393	683
1991	250	279	529
1992	54	224	278
1993	39	122	161
1994	25	116	141

[1] Difference between total and sum of small and large are due to rounding.

Table 5.1.2.3 Nominal catches (numbers of fish) in Canadian recreational Atlantic salmon fishery. 1974-1994. Catches for 1994 are preliminary.

Year	Small	Large	Total[1]
1974	53,887	31,720	85,607
1975	50,463	22,714	73,177
1976	66,478	27,686	94,164
1977	61,727	45,495	107,222
1978	45,240	28,138	73,378
1979	60,105	13,826	73,931
1980	67,314	36,943	104,257
1981	84,177	24,204	108,381
1982	72,893	24,640	97,533
1983	53,385	15,950	69,335
1984	66,676	9,982	76,658
1985	72,389	10,084	82,473
1986	94,046	11,797	105,843
1987	66,475	10,069	76,544
1988	91,897	13,295	105,192
1989	65,446	11,196	76,642
1990	74,541	12,788	87,329
1991	46,410	11,219	57,629
1992	77,577	12,286	90,403
1993	68,343	9,919	78,262
1994	60,236	11,179	71,415

[1] Difference between total and sum of small and large are due to rounding.

Table 5.1.4.1. List of input parameters by river and year (i+1) used to estimate run size and tag returns to Maine rivers. Data for years prior to 1988 are the same as those given in Anon. (1989), except those listed below. Ta = number of tagged salmon recovered by anglers, Ua = number of untagged salmon recovered by anglers, Tt = number of tagged salmon recovered at the trap, and Ut = number of untagged salmon recovered at the trap. Rivers:1=Penobscot, 2=Union, 3=Narraguagus, 4=Pleasant, 5=Machias, 6=East Machias, 7=Dennys, 9=Kennebec, 10=Androscoggin, 11=Sheepscot, 12=Ducktrap, 13=Saco

1994

River	Ta	Ua	Tt	Ut
1	0	0	7	716
2	0	0	0	0
3	0	0	0	42
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	1	0	0
9	0	0	0	0
10	0	0	0	22
11	0	0	0	0
12	0	0	0	0
13	0	0	0	17

Table 5.1.4.2. Estimated Carlin tag recoveries and run size in Maine rivers. Ratio of tag to run size of 2SW salmon in homewaters. RATIO (year i) for use in estimation of distant water harvest (year i-1).

Year	Tags	Run	RATIO
1967	0	1019	0.0000
1968	168	729	0.2307
1969	7	690	0.0104
1970	13	856	0.0155
1971	68	687	0.0985
1972	318	1449	0.2197
1973	206	1448	0.1425
1974	215	1411	0.1520
1975	450	2345	0.1920
1976	184	1341	0.1374
1977	97	2025	0.0478
1978	97	4145	0.0233
1979	36	1878	0.0190
1980	0	5662	0.0000
1981	470	5122	0.0918
1982	284	6023	0.0472
1983	138	1930	0.0716
1984	61	3045	0.0202
1985	185	4855	0.0381
1986	309	5568	0.0555
1987	119	2397	0.0498
1988	319	2855	0.1118
1989	190	2946	0.0646
1990	172	4370	0.0393
1991	29	2057	0.0138
1992	28	1888	0.0150
1993	37	1980	0.0185
1994	8	958	0.0086

Table 5.1.4.3. Carlin tag returns from 1SW salmon of Maine origin in Newfoundland and Labrador by year and Salmon Fishing Area. (99=unknown area)

	SFA															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	99	TOT
1967	3	1	7	14	5	0	4	0	1	1	2	0	0	0	2	40
1968	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	3
1969	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	3
1970	5	2	13	5	1	1	0	1	0	1	0	0	0	0	0	29
1971	10	2	4	18	10	3	0	0	0	0	1	0	0	0	0	48
1972	6	1	0	0	4	0	0	0	0	0	0	1	0	0	0	12
1973	6	1	6	4	1	1	1	3	1	0	0	0	0	1	0	25
1974	0	5	19	38	13	10	5	3	3	3	0	1	0	3	0	103
1975	16	4	18	36	13	6	1	4	1	2	0	0	0	1	0	102
1976	18	6	26	14	5	5	0	0	0	3	2	0	0	1	0	80
1977	2	1	6	5	0	0	0	0	0	1	1	0	0	0	0	16
1978	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5
1980	55	24	112	72	22	6	0	3	2	3	12	0	0	3	1	315
1981	14	0	2	10	7	5	1	0	1	0	0	0	0	1	0	41
1982	14	7	20	21	7	6	1	0	0	1	4	0	2	2	0	85
1983	8	1	11	6	0	0	0	0	0	0	0	0	0	0	0	26
1984	12	4	7	7	4	2	1	0	0	1	1	0	0	0	0	39
1985	20	3	15	36	11	1	3	2	0	0	0	0	0	2	1	94
1986	3	5	6	2	1	0	0	1	0	0	0	0	0	3	0	21
1987	14	2	16	4	6	2	0	2	1	1	0	0	0	0	1	49
1988	8	2	5	0	1	0	1	0	0	1	1	0	0	1	0	20
1989	25	5	10	6	4	1	1	1	0	1	0	0	0	0	0	54
1990	0	2	2	2	0	0	0	0	0	0	2	0	0	0	0	8
1991	0	0	13	1	1	0	0	0	0	0	0	0	0	0	0	15
1992	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	4
1993	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Unk	5	0	2	4	0	0	1	1	0	0	1	0	0	1	0	15
TOT	248	81	324	307	117	50	20	22	10	19	27	2	2	19	5	1253

Table 5.1.4.4. Estimated harvest of 1SW salmon of Maine origin in Newfoundland and Labrador by year and Salmon Fishing Area. (99=unknown area)

	SFA															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	99	Tot
1967	14	5	43	87	31	0	25	0	6	6	12	0	0	0	12	242
1968	0	0	0	274	137	0	0	0	0	0	0	0	0	0	0	411
1969	0	0	185	0	0	0	0	92	0	0	0	0	0	0	0	277
1970	56	23	188	72	14	14	0	14	0	14	0	0	0	0	0	398
1971	51	10	26	117	65	20	0	0	0	0	7	0	0	0	0	295
1972	47	8	0	0	40	0	0	0	0	0	0	10	0	0	0	105
1973	44	7	56	38	9	9	9	28	9	0	0	0	0	9	0	220
1974	0	29	141	283	97	74	37	22	22	22	0	7	0	22	0	758
1975	129	32	187	374	135	62	10	42	10	21	0	0	0	10	0	1014
1976	418	139	777	418	149	149	0	0	0	90	60	0	0	30	0	2230
1977	95	48	368	307	0	0	0	0	0	61	61	0	0	0	0	940
1978	234	0	75	0	0	0	0	0	0	0	0	0	0	0	0	309
1980	666	291	1744	1121	343	93	0	47	31	47	187	0	0	47	16	4631
1981	330	0	61	303	212	151	30	0	30	0	0	0	0	30	0	1147
1982	217	109	399	419	140	120	20	0	0	20	80	0	40	40	0	1603
1983	441	55	779	425	0	0	0	0	0	0	0	0	0	0	0	1700
1984	350	117	262	262	150	75	37	0	0	37	37	0	0	0	0	1329
1985	400	60	386	926	283	26	77	51	0	0	0	0	0	51	26	2288
1986	67	112	172	57	29	0	0	29	0	0	0	0	0	86	0	552
1987	139	20	204	51	77	26	0	26	13	13	0	0	0	0	13	580
1988	138	34	111	0	22	0	22	0	0	22	22	0	0	22	0	393
1989	708	142	364	218	146	36	36	36	0	36	0	0	0	0	0	1722
1990	0	161	207	207	0	0	0	0	0	0	207	0	0	0	0	780
1991	0	0	1235	95	95	0	0	0	0	0	0	0	0	0	0	1425
1992	0	120	77	0	0	77	0	0	0	0	0	0	0	0	0	275
1993	0	129	0	0	0	0	0	0	0	0	0	0	0	0	0	129
Tot	4544	1650	8049	6055	2173	934	305	388	123	390	673	17	40	349	66	25756

Table 5.1.4.5. Estimated total run size of 1SW and 2SW salmon returning to Maine rivers and estimated harvests of 1SW salmon in Newfoundland and Labrador fisheries All run size and harvest estimates are computed assuming 85 percent fish passage efficiency.

Year i	Run 1SW i	2SW i+1	1/2SW Ratio	Harvest i	Harvest /2SW Run Ratio
1967	100	729	0.138	242	0.332
1968	24	690	0.035	411	0.595
1969	36	856	0.041	277	0.324
1970	14	687	0.021	398	0.579
1971	44	1449	0.030	295	0.204
1972	32	1448	0.022	105	0.072
1973	43	1411	0.030	220	0.156
1974	99	2345	0.042	758	0.323
1975	116	1341	0.086	1014	0.756
1976	231	2025	0.114	2230	1.101
1977	98	4145	0.024	940	0.227
1978	161	1878	0.086	309	0.165
1979	251	5662	0.044	NA	NA
1980	847	5122	0.165	4631	0.904
1981	1148	6023	0.191	1147	0.191
1982	315	1930	0.163	1603	0.831
1983	271	3045	0.089	1700	0.558
1984	388	4855	0.080	1329	0.274
1985	337	5568	0.061	2288	0.411
1986	711	2397	0.297	552	0.230
1987	950	2855	0.333	580	0.203
1988	896	2946	0.304	393	0.134
1989	1267	4370	0.290	1722	0.394
1990	654	2057	0.318	780	0.379
1991	301	1888	0.159	1425	0.755
1992	1178	1980	0.595	275	0.139
1993	477	958	0.498	129	0.135

NA=Not Available since no smolts were tagged in 1978.

Table 5.1.5.1 Exploitation rate in recreational fisheries

SFA	No. of rivers		Exploitation rate in open monitored rivers		
	Monitored	Closed	<10%	10% to 30%	>30%
Large and small salmon					
Q1-Q3, Q10	35	9	1	13	12
Q5-Q9	15	6	0	6	3
Q11	0	0	0	0	0
14B, 1, 2	2	0	1	0	1
Sub-total	52	15	2	19	16
			5%	**51%**	**43%**
Small salmon only					
14 A, 3-8	7	0	1	4	2
9-11	3	1	1	1	0
12-13	2	0	1	0	1
15-16	5	0	1	3	1
17-18	5	0	0	0	5
19-21	5	0	1	1	3
22-23	33	33	0	0	0
Maine	7	1	6	0	0
Sub-total	67	35	11	9	12
			34%	**28%**	**38%**
Total	119	50	13	28	28

Table 5.1.5.2. Summary of input data for estimation of exploitation rates for Maine origin Atlantic salmon.

Year (i)	Run2 (i+1)	GH2 (i+1)	CH2 (i+1)	USAC (i+1)	NN2 (i+1)	GH1 (i)	CH1 (i)	RUN3 (i+2)	RUN1 (i)	VAR CA
1967	729	18	50	0	161	226	242	20	100	2
1968	690	135	274	0	274	0	411	19	24	2
1969	856	0	92	0	92	545	277	14	36	2
1970	687	100	135	14	14	828	398	47	14	2
1971	1449	77	12	7	52	2446	295	10	44	2
1972	1448	118	66	30	20	809	105	45	32	2
1973	1411	65	9	28	38	1212	220	17	43	2
1974	2345	73	65	30	7	2615	758	5	99	2
1975	1341	0	8	0	0	1299	1014	9	116	2
1976	2025	0	90	30	60	1529	2230	21	231	2
1977	4145	80	61	0	0	886	940	4	98	2
1978	1878	0	59	0	0	1066	309	6	161	2
1980	5122	61	135	0	0	2207	4631	30	847	2
1981	6023	143	144	30	60	1908	1147	11	1148	2
1982	1930	104	31	0	20	1283	1603	12	315	2
1983	3045	69	0	0	0	488	1700	9	271	2
1984	4855	0	95	0	0	849	1329	25	388	2
1985	5568	51	66	0	0	1469	2288	49	337	2
1986	2397	0	0	0	0	2035	552	7	711	2
1987	2855	38	49	13	0	2087	580	9	950	2
1988	2946	22	61	44	0	2309	393	20	896	1.5
1989	4370	36	28	0	0	3797	1722	5	1267	1
1990	2057	0	103	0	0	1525	780	2	654	1
1991	1888	0	0	0	0	1777	1425	10	301	1
1992	1980	0	0	0	0	1067	275	3	1178	1
1993	958	0	0	0	0	327	129		477	1

KEY
Run2 = Estimated total run of 2SW salmon to Maine rivers
GH2= Harvest of 2SW salmon in Greenland
CH2= Harvest of 2SW salmon in Canada
USAC= Harvest of 2SW salmon in USA coastal waters
NN2 = Non- Newfoundland 2SW harvests
GH1= Harvest of 1SW salmon in Greenland
CH1= Harvest of 1SW salmon in Canada
RUN3 = Estimated total run of 3SW salmon to Maine Rivers
RUN1 = Estimated total run of 1SW salmon to Maine Rivers
VAR CA=Varible Carlin Reporting Rate Adjustment

Table 5.1.5.3. Estimated exploitation rate of 1SW and 2SW salmon for the extant population of Maine origin stocks.

Fishery Year	1SW Salmon Carlin Adjustment 1	2	Var	2SW Salmon 1	2	Var
1967	0.30	0.41	0.41			
1968	0.21	0.26	0.26	0.75	0.86	0.86
1969	0.41	0.54	0.54	0.95	0.98	0.98
1970	0.52	0.63	0.63	0.86	0.92	0.92
1971	0.60	0.74	0.74	0.82	0.90	0.90
1972	0.32	0.45	0.45	0.89	0.94	0.94
1973	0.45	0.60	0.60	0.78	0.88	0.88
1974	0.54	0.69	0.69	0.79	0.88	0.88
1975	0.60	0.75	0.75	0.96	0.98	0.98
1976	0.60	0.74	0.74	0.45	0.63	0.63
1977	0.28	0.42	0.42	0.80	0.89	0.89
1978	0.39	0.55	0.55	0.97	0.99	0.99
1980	0.53	0.69	0.69	0.90	0.95	0.95
1981	0.30	0.45	0.45	0.86	0.92	0.92
1982	0.55	0.70	0.70	0.96	0.98	0.98
1983	0.39	0.55	0.55	0.91	0.95	0.95
1984	0.28	0.44	0.44	0.88	0.94	0.94
1985	0.37	0.53	0.53	0.77	0.87	0.87
1986	0.49	0.66	0.66	0.68	0.81	0.81
1987	0.45	0.61	0.61	0.00	0.00	0.00
1988	0.44	0.60	0.54	0.90	0.95	0.93
1989	0.53	0.69	0.53	0.78	0.88	0.78
1990	0.49	0.65	0.49	0.92	0.96	0.92
1991	0.60	0.75	0.60	0.97	0.99	0.97
1992	0.38	0.55	0.38	0.00	0.00	0.00
1993	0.30	0.46	0.30	0.00	0.00	0.00
AVG10	0.43	0.59	0.51	0.59	0.64	0.62
AVG	0.44	0.58	0.55	0.74	0.80	0.79

AVG10=Average last ten years, AVG=Average time series

Table 5.1.5.4. Estimates of exploitation rates for the reduced model in the fisheries of Newfoundland-Labrador and West Greenland for varying levels of P, the fraction of the stock migrating from Canada, (1-P, is fraction from Greenland) and for two levels of adjustment for reporting rate of Carlin tags.

	Canada			Greenland		
Fishery	P			1-P		
Year (i)	0.1	0.5	0.9	0.9	0.5	0.1
1967	0.86	0.54	0.40	0.38	0.53	0.85
1968	0.91	0.68	0.54	0.00	0.00	0.00
1969	0.85	0.54	0.39	0.56	0.69	0.92
1970	0.91	0.68	0.54	0.71	0.81	0.96
1971	0.79	0.42	0.29	0.77	0.86	0.97
1972	0.57	0.21	0.13	0.53	0.67	0.91
1973	0.74	0.36	0.24	0.63	0.75	0.94
1974	0.85	0.54	0.39	0.69	0.80	0.95
1975	0.93	0.73	0.60	0.66	0.78	0.95
1976	0.95	0.80	0.69	0.60	0.73	0.93
1977	0.80	0.45	0.31	0.30	0.43	0.79
1978	0.75	0.37	0.25	0.53	0.67	0.91
1980	0.94	0.77	0.64	0.46	0.61	0.89
1981	0.77	0.41	0.28	0.39	0.53	0.85
1982	0.94	0.75	0.62	0.57	0.70	0.92
1983	0.91	0.67	0.53	0.24	0.36	0.74
1984	0.83	0.50	0.35	0.26	0.38	0.76
1985	0.88	0.60	0.45	0.34	0.49	0.82
1986	0.81	0.45	0.32	0.63	0.75	0.94
1987	0.79	0.42	0.29	0.59	0.72	0.93
1988	0.64	0.27	0.17	0.54	0.68	0.91
1989	0.78	0.42	0.28	0.46	0.61	0.89
1990	0.77	0.41	0.28	0.42	0.57	0.87
1991	0.87	0.58	0.43	0.48	0.63	0.89
1992	0.56	0.20	0.12	0.35	0.49	0.83
1993	0.55	0.20	0.12	0.25	0.38	0.75
AVG10	0.83	0.52	0.39	0.49	0.61	0.85
AVG	0.82	0.51	0.37	0.45	0.59	0.87

AVG10=Average last ten years, AVG=Average time series

Table 5.2.1.1 Summary of spawning target estimates for North America by geographical region.

Region[1]	Target	Minimum Value	Maximum Value	Documentation
SFA 1	7300	5600	9000	Estimates for SFA 1 and 2 are imputed from the minimum and maximum values of total catches (recreational + commercial + native) in Labrador and part of the catch in Greenland for the period 1974-1978. Min. value = {[Average of the minimum 2SW salmon returns in Labrador for 1974-1978 in SFA1]} + [Average catch of North American origin 1SW salmon with river age >3 caught at Greenland (1974-1978), discounted for 10 months of natural mortality (10%), = 47,700]. * [Assumed fraction of Labrador origin salmon (>3), = 0.70]. * [Average fraction of SFA1 + SFA2 Labrador catch taken in SFA1, = 0.27]}. * [Average fraction of 2SW salmon in spawning run = 0.30]. = {[9,517] + [47,700] * [0.70] [0.27]} * [0.3]. Max. value= {[Average max. 2SW return in Labrador for 1974-1978 in SFA1]. + (other terms listed for min. value)} = {[20,976] + [47,700] * [0.70] [0.27]} [0.3]. Mean value= [Min + Max]/2. Values rounded to nearest 100.
SFA 2	20300	15,200	25,300	Minimum and maximum values for SFA2 are computed as in SFA1 except that average fraction of SFA1 + SFA2 Labrador catch taken in SFA2 is 0.73. Min. value= {[29,295] + [47,700] * [0.70] * [0.73]} *[0.3]. Max. value = {[60,102] + [47,700] * [0.70] * [0.73]} * [0.3]. Values rounded to nearest 100.
SFA 3	200			Updated from Anon., 1978 to include production in lacustrine habitat and newly colonized areas.
SFA 4	2000			See SFA 3
SFA 5	800			See SFA 3
SFA 6	50			See SFA 3
SFA 7	40			See SFA 3
SFA 8	13			See SFA 3
SFA 9	400			See SFA 3
SFA 10	400			See SFA 3
SFA 11	800			See SFA 3
SFA 12	100			See SFA 3
SFA 13	5300			See SFA 3
SFA 14	800			See SFA 3
SFA 15	13736	12629	14153	Target for large salmon is 15600 per CAFSAC advisory document 91/16. Target value is sum of 3 rivers in SFA 15:

Table 5.2.1.1 Continued

Region[1]	Target	Minimum Value	Maximum Value	Documentation
				Restigouche, Eel, Nepisiquit. Min value is Restigouche target/max proportion of Restigouche in SFA 15 = 12200/0.966. Max value is Restigouche target /min proportion of Restigouche in SFA 15 = 12200/0.862.
SFA 16	27800	24651	29500	CAFSAC Adv. Doc. 91/16. Tabled spawning targets for 4 rivers in SFA 16 (Miramichi, Tabusintac, Richibucto, Buctouche. Maximum value = Miramichi target/0.8 where 0.8 represents proportion of SFA 16 watershed in Miramichi drainage.
SFA 17	1100			CAFSAC Adv. Doc. 91/16; CAFSAC Subcomm. Rep. 91/13. Tabled target for Morell River + broodstock requirement for other rivers.
SFA 18	1843	1571	2114	CAFSAC Adv. Doc. 91/16; CAFSAC Res. Doc. 92/26. Tabled targets for Margaree, East R. , West R., South R., Afton/Pomquet. Max value = Target for Margaree/ min prop. for Margaree to SFA 18 = 1036/0.49
SFA 19	1395	1300	1490	An update from Anon, 1978 where NewMin = Min* 0.7, NewMax=Max*0.8
SFA 20[3]	2400	2240	2560	An update from Anon, 1978 where NewMin = Min* 0.7, NewMax=Max*0.8
SFA 21[3]	2050	1910	2190	An update from Anon, 1978 where NewMin = Min* 0.7, NewMax=Max*0.8
SFA 22	0	0	0	No significant contribution to distant water fisheries
SFA 23	9995	9440	10550	Marshall and Penney, 1983 and Anon. 1978 where NewMin=Min*0.85; NewMax = Max*0.95 .
Q 1[2]	5199			Caron, unpubl. data. slight increase fromTable 6.1.2.2 (Anon., 1993a)
Q 2[2]	3070			Caron, unpubl. data.slight increase from Table 6.1.2.2 (Anon., 1993a)
Q 3[2]	3559			Caron, unpubl. data. slight increase fromTable 3.2.1.1 (Anon., 1994a)
Q 5[2]	787			Caron, unpubl. data,decrease from Table 3.2.1.1. (Anon. 1994a) due to recaluclation of habitat in Jacques Cartier River.
Q 6[2]	2085			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 7[2]	7142			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 8[2]	18244			Caron, unpubl. data. slight decrease from Table 6.1.2.2 (Anon., 1993a)
Q 9[2]	7359			Caron, unpubl. data. slight increase from Table 6.1.2.2 (Anon., 1993a)
Q 10[2]	3520			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Q 11[2]	7500			Caron, unpubl. data. Table 6.1.2.2 (Anon., 1993a)
Canadian Total	157287			

Table 5.2.1.1 Continued

Region[1]	**Target**	**Minimum Value**	**Maximum Value**	**Documentation**
USA Rivers				
Connecticut	9727			See Table 8.2.1
Merrimack	2599			See Table 8.2.1
Penobscot	6838			See Table 8.2.1
Other Maine	9668			Kennebec River has been excluded because its habitat is not accessible. Estimates include areas accessible via trap and truck operations. (See Table 8.2.1).
Paucatuck	367			
USA Total	29199			
Grand Total	186486			

[1]SFA = Salmon Fishing Area of Atlantic Canada, Zones in Quebec are designated by Q prefix.
[2]Point Estimate of 2SW spawners
[3]Targets under review due to acidification.

Table 5.2.2.1 Returns of Atlantic salmon to rivers of eastern Canada in 1994 compared to returns during 1984 to 1993.

Rank of the 1994 returns of individual rivers within the last 11 years and within the last 6 years. A rank of 1 means the return in 1994 was the highest of the time series for that river. A rank of 11 in the eleven year time series means that the 1994 return was the lowest observed in 11 years for that river. The median rank represents the rank of the 1994 returns for which half the rivers were above and half were below. For example, for the 5 rivers assessed in the Bay of Fundy/Atlantic coast of Nova Scotia, the highest rank for the small salmon return in 1994 for any of the five rivers was fourth out of eleven, the lowest rank of one of the rivers was eleven or the lowest observed in the 11 year time series and the median rank was 10 to 11. This means that at least 2 rivers had a rank of 11, a third river had a rank of 10 or 11 and two rivers had ranks which were better than 10.

	Rank of 1994 within 1984 to 1994 period				**Rank of 1994 within 1989 to 1994 period**			
Size group	**# of rivers**	**High**	**Low**	**Median**	**# of rivers**	**High**	**Low**	**Median**
	Bay of Fundy / Atlantic coast of Nova Scotia							
Small	5	4	11	10-11	5	1	6	5
Large	5	1	11	11	5	2	6	5-6
	Rivers flowing into the Gulf of St. Lawrence							
Small + Large	16	3	11	6	16	1	6	4
Small	9	1	9	6	9	1	6	5
Large	9	1	10	8	10	1	6	6
	South, northeast Newfoundland and Labrador							
Small	4	1	7	2	8	1	4	3
Large	4	2	6	4	9	1	6	3

Table 5.2.2.2. Estimated numbers of 2SW returns in North America by geographic regions, 1974-1994

YEAR	Labrador		Newfoundland		Gulf of St.Lawrence		Quebec		Scotia-Fundy		USA	Total		
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid Point
1974	4,324	29,566	393	2,361	51,273	92,207	43,041	63,894	19,844	26,169	1,412	120,287	215,608	167,948
1975	4,108	27,969	418	2,507	36,815	69,858	36,994	55,069	23,069	29,295	2,348	103,752	187,046	145,399
1976	4,860	32,972	329	1,975	40,449	79,589	38,806	57,755	20,462	27,121	1,343	106,249	200,755	153,502
1977	4,066	27,654	337	2,020	73,104	134,698	43,150	69,334	27,223	36,409	2,032	149,912	272,147	211,029
1978	3,366	22,779	191	1,145	40,557	73,882	35,311	56,379	16,475	21,340	4,235	100,135	179,759	139,947
1979	2,044	13,829	186	1,116	14,495	29,949	20,330	30,422	8,587	12,083	1,928	47,570	89,328	68,449
1980	4,782	32,533	214	1,283	56,831	104,955	47,910	75,464	30,532	41,768	5,826	146,094	261,829	203,962
1981	4,355	29,577	251	1,504	29,529	58,940	35,565	54,467	18,329	26,752	5,635	93,664	176,876	135,270
1982	3,184	21,676	139	836	40,357	76,212	35,341	56,528	16,856	22,760	6,144	102,022	184,157	143,089
1983	2,197	14,915	175	1,053	36,160	68,575	30,358	44,963	13,380	18,677	2,101	84,372	150,284	117,328
1984	1,525	10,378	155	930	25,717	50,052	26,768	41,129	16,243	24,842	3,186	73,594	130,518	102,056
1985	1,277	8,629	81	484	32,829	65,022	30,944	47,583	20,643	35,158	5,363	91,137	162,238	126,688
1986	2,214	15,038	191	1,147	48,811	97,638	37,726	57,536	17,210	31,602	5,963	112,116	208,924	160,520
1987	2,809	19,115	201	1,204	32,408	69,805	36,315	53,453	11,071	19,650	2,861	85,665	166,089	125,877
1988	1,860	12,654	166	995	37,133	75,175	39,149	61,020	10,269	19,378	3,008	91,585	172,230	131,907
1989	1,807	12,249	100	600	28,131	57,640	33,503	52,110	11,406	20,453	3,137	78,084	146,189	112,137
1990	1,015	6,909	160	959	38,544	87,766	33,188	53,090	10,184	18,469	4,859	87,950	172,052	130,001
1991	369	2,517	120	723	30,115	64,761	32,277	50,951	9,915	16,551	2,594	75,390	138,097	106,744
1992	1,207	8,238	549	3,294	33,050	68,610	32,492	52,532	9,225	15,425	2,540	79,063	150,639	114,851
1993	4,170	16,612	282	1,695	19,195	77,474	25,956	41,135	6,725	11,427	2,237	58,565	150,579	104,572
1994	5,545	22,930	213	1,277	25,260	64,330	40,342	65,617	4,421	7,281	1,309	77,089	162,743	119,916
Mean	2,645	17,419	221	1,325	35,500	71,562	33,101	51,182	15,126	22,635	3,274	89,867	167,397	128,632

Labrador: SFAs 1&2
Newfoundland: SFAs 3-11
Gulf of St. Lawrence: SFAs12-18
Scotia-Fundy:SFA 19-23(not incl. SFA 22 as does not produce 2SW)
Quebec: Q1-Q11

Table 5.2.3.1 Egg depositions relative to target during 1984 to 1994 for the assessed rivers in eastern Canada.

		Year of spawning of small and large salmon									
		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Bay of Fundy / Atlantic Coast of Nova Scotia (% of rivers assessed)											
# of rivers assessed		2	2	2	2	4	4	4	5	5	13
Depositions as % of target	>=100%	100%	50%	50%	50%	75%	50%	50%	20%	20%	10%
	<50%	0%	0%	0%	0%	0%	25%	0%	40%	60%	90%
Rivers flowing into the Gulf of St. Lawrence (% of rivers assessed)											
# of rivers assessed		27	27	27	27	26	26	26	29	32	36
Depositions as % of target	>=100%	26%	37%	56%	70%	54%	42%	54%	55%	38%	36%
	<50%	26%	4%	11%	7%	4%	8%	8%	17%	19%	19%
South and Northeast Newfoundland and Labrador (% of rivers assessed)											
# of rivers assessed		4	5	6	10	11	11	11	11	12	14
Depositions as % of target	>=100%	50%	60%	67%	40%	27%	27%	9%	36%	42%	36%
	<50%	25%	20%	33%	40%	55%	55%	73%	45%	33%	43%

Table 5.2.3.2 Estimated numbers of returning and spawning Atlantic salmon, egg depositions, ratios of large salmon spawners to returns and fraction of target egg deposition attained in 16 rivers in Atlantic Canada. Empty cells mean no prediction available. Bold numbers are target spawners and eggs.

Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
	Small	Large	Predicted Large	Small	Large			
Restigouche River - SFA 15								
TARGET				**2.6**	**12.2**	**71.4**		
1982	8.0	11.2		2.0	1.8	10.9	0.16	0.15
1983	3.4	10.2	13.5	0.6	1.4	8.7	0.14	0.12
1984	10.9	7.8	11.3	1.3	3.1	18.6	0.40	0.26
1985	7.0	10.0	12.2	2.5	6.3	37.4	0.63	0.52
1986	10.7	14.1	14.8	3.8	8.8	52.6	0.63	0.74
1987	10.0	10.2	21.9	3.5	5.9	35.0	0.58	0.49
1988	13.5	12.7	12.9	4.7	8.2	49.3	0.65	0.69
1989	6.7	10.6		2.3	6.2	37.1	0.58	0.52
1990[2]	10.2-	10.5-		4.3-	6.3-	37.9-	0.65[5]	0.53-
	17.1	16.4		10.1	11.3	68.0		0.95
1991[2]	5.9-	8.6-		2.5-	5.1-	30.4-	0.64[5]	0.43-
	9.8	13.6		5.9	9.3	55.5		0.78
1992[2]	11.1-	11.8-		4.8-	7.4-	44.3-	0.67[5]	0.62-
	18.5	18.7		11.1	13.2	79.3		1.11
1993[2]	7.6	6.1		3.2	3.3	20.1	0.65	0.28
	12.7	9.3		7.6	6.1	36.8		0.52
1994	11	11		5	6	40	0.55	0.56
	19	17		11	12	72	0.71	1.01
Miramichi River[1] - SFA 16								
TARGET				**23.6**	**22.6**	**132.0**		
1982	80.4	30.8		56.0	13.3	109.8	0.40	0.83
1983	25.2	27.9	43.0	14.8	8.5	48.1	0.27	0.36
1984	29.7	15.1	10.2	18.9	14.7	77.0	0.91	0.58
1985	60.8	20.7	18.4	41.8	20.1	130.0	0.92	0.98
1986	117.5	31.3	28.4	89.4	30.2	226.4	0.93	1.72
1987	84.8	19.4	54.2	62.8	18.1	175.9	0.88	1.42
1988	121.9	21.7	36.4	90.3	21.0	189.3	0.92	1.50
1989	75.2	17.2	-	48.4	15.5	124.1	0.84	0.98
1990	83.4	28.6	-	59.7	27.6	191.2	0.93	1.52
1991	60.9	29.9	26.0	48.3	29.1	200.6	0.94	1.59
1992	152.7	37.0	29.0	135.2	35.9	319.4	0.97	2.42
1993	92.4	35.2	18.3	76.4	34.7	224.4	0.99	1.70
1994	56.0	27.0		42.0	27.0	171.6	0.99	1.30

Table 5.2.3.2 Continued

Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
	Small	Large	Predicted Large	Small	Large			
Saint John River above Mactaquac Dam[1] - SFA 23								
TARGET				**3.2**	**4.4**	**29.5**		
1982	8.2	7.3		4.9	2.3	18.9	0.31	0.64
1983	6.1	6.9		3.7	1.3	9.6	0.19	0.33
1984	9.8	10.9	6.2	6.9	6.1	40.2	0.56	1.36
1985	8.5	11.3	9.3	5.3	6.3	41.2	0.56	1.40
1986	8.8	6.9	8.8	5.9	3.5	26.5	0.51	0.90
1987	9.2	4.8	11.0	7.0	2.8	24.3	0.58	0.82
1988	10.2	3.5	8.0	7.8	1.7	16.0	0.49	0.54
1989	10.9	4.5	7.1	7.5	3.5	28.5	0.78	0.97
1990	8.8	4.1	7.1	6.1	3.2	27.1	0.78	0.92
1991	8.8	5.2	4.7	5.7	3.5	26.9	0.67	0.91
1992	8.9	4.9	5.1	5.1	3.3	24.7	0.67	0.84
1993	4.4	3.4	4.8-5.4	2.8	2.1	15.0	0.62	0.51
1994	3.5	2.4	3.1-4.8	2.9	1.6	11.4	0.82	0.39
LaHave River above Morgan Falls[12] - SFA 21								
TARGET[7]				--	--	--		
1983	1.1	0.2		1.1	0.2	2.0	1.00	
1984	2.0	0.4	0.2[3]	2.0	0.3	3.1	0.75	
1985	1.3	0.6	0.3[3]	1.3	0.4	3.4	0.67	
1986	1.6	0.6	0.4[3]	1.6	0.4	4.1	0.67	
1987	2.5	0.5	0.4[3]	2.5	0.4	4.9	0.80	
1988	2.5	0.4	0.7[3]	2.4	0.3	4.4	0.75	
1989	2.1	0.5		2.1	0.4	4.3	0.80	
1990	1.9	0.6		1.9	0.3	3.4	0.75	
1991	0.5	0.2		0.4	0.2	1.4	0.73	
1992	1.9	0.2		1.8	0.2	2.9	0.67	
1993	0.8	0.1		0.6	0.1	1.1	0.68	
1994	0.6	0.1		0.6	0.1	1.2	0.79	
Marqaree River[1] - SFA 18								
TARGET				**0.6**	**1.0**	**6.7**		
1983	0.2	0.5		0.1	0.3	1.8	0.60	0.27
1984	0.4	0.4		0.2	0.3	2.0	0.75	0.30
1985	0.6	0.8		0.4	0.8	5.3	1.00	0.79
1986	0.8	2.0		0.5	2.0	12.9	1.00	1.93
1987	1.5	4.0		1.1	4.0	25.9	1.00	3.87
1988	2.2	1.7		1.6	1.7	11.1	1.00	1.65
1989	0.8	2.3		0.3	2.2	14.0	0.96	2.09
1990	2.0	5.2		1.5	5.0	32.5	0.97	4.85
1991	1.9	3.5		1.3	3.3	21.5	0.95	3.21
1992	1.6	6.4		1.1	6.2	40.3	0.98	6.01
1993	2.1	3.4		1.5	3.2	20.8	0.96	3.11
1994	0.7	2.9		0.4	2.6	17.8	0.95	2.66

Table 5.2.3.2 Continued

Year	Returns (10^3) Small	Returns (10^3) Large	Returns (10^3) Predicted Large	Spawners (10^3) Small	Spawners (10^3) Large	Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
Conne River - SFA 11[11]								
TARGET				**4.0**	-	**7.8**		
1986	8.3	0.4		5.4	0.4	11.3	0.65[4]	1.45
1987	10.2	0.5		7.8	0.5	16.7	0.77[4]	2.14
1988	7.6	0.4	7.9-8.8	5.6	0.4	12.4	0.74[4]	1.59
1989	5.0	0.3	6.2-6.8	3.6	0.3	8.0	0.72[4]	1.03
1990	5.4	0.4	6.8-7.9	3.8	0.4	8.7	0.70[4]	1.12
1991	2.4	0.1	4.5-5.3	2.1	0.1	4.0	0.88[4]	0.51
1992	2.5	0.2	3.5-7.2	1.8	0.2	4.0	0.71[4]	0.51
1993	2.7	0.1		2.4	0.1	4.8	0.87[4]	0.61
1994	1.5	0.1		1.4	0.1	3.1	0.94[4]	0.40
Rivière de la Trinité - Q7								
TARGET				**1.0**	**0.5**	**2.7**		
1982	2.4	0.3		1.6	0.2	1.2	0.66	0.45
1983	0.9	0.5		0.7	0.5	2.3	1.00	0.85
1984	1.8	0.5		1.4	0.4	2.2	0.80	0.82
1985	1.1	0.6		0.9	0.4	2.1	0.67	0.78
1986	1.6	0.6		1.1	0.4	2.3	0.67	0.86
1987	1.3	0.6		0.8	0.4	2.5	0.67	0.91
1988	1.6	0.8		1.0	0.7	4.1	0.88	1.35
1989	1.8	0.5		1.3	0.3	2.2	0.60	0.71
1990	1.9	0.5		1.2	0.4	2.5	0.80	0.81
1991	1.3	0.5		1.0	0.4	2.3	0.77	0.75
1992	0.6	0.6		0.4	0.5	2.6	0.74	0.84
1993	0.4	0.3		0.2	0.2	1.2	0.79	0.41
1994	0.6	0.3		0.4	0.3	1.8	0.83	0.61
Humber River - SFA 13								
TARGET				**18**	**6**	**27.7**		
1987	12.3	0.9		9.2	0.9	16.1	1.00	0.58
1988	16.2	1.1		12.1	1.1	12.4	1.00	0.77
1989	4.9	0.3		3.7	0.3	2.9	1.00	0.23
1990	12.2	0.9		9.2	0.9	16.0	1.00	0.58
1991	5.7	0.4		4.3	0.4	7.5	1.00	0.27
1992	17.6	2.9		13.2	2.9	44.0	1.00	1.55
1993	18.5	0.6		14.3	0.6	27.2	1.00	0.96
1994	8.0	1.0		5.5	1.0	11.3	1.00	0.40
Gander River - SFA 4								
TARGET				**22**	-	**46.2**		
1989	7.7	0.47		6.6	0.45	16.3	1.00	0.35
1990	7.7	0.51		6.6	0.51	16.5	1.00	0.36
1991	6.7	0.67		5.6	0.67	15.1	1.00	0.33
1992	18.4	4.18		17.0	4.18	51.2	1.00	1.11
1993	25.9	1.73		24.9	1.73	62.7	1.00	1.36
1994	18.3	1.07		16.2	1.07	41.2	1.00	0.89

Table 5.2.3.2 Continued

Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
	Small	Large	Predicted Large	Small	Large			
Rocky River - SFA 9								
TARGET				**0.9**	-	**3.4**		
1987	0.08			0.2[9]		0.8		0.23
1988	0.3			0.3		1.2		0.36
1989	0.2			0.2		0.7		0.20
1990	0.4			0.4		1.6		0.47
1991	0.2			0.2		0.9		0.26
1992	0.3			0.3		1.1		0.32
1993	0.3			0.3		1.4		0.41
1994	0.2			0.2		1.0		0.30
Terra Nova River - SFA 5								
TARGET[6]				**7.1**	-	**14.3**		
1986	1.5	0.14		1.0	0.14	2.7	1.00	0.19
1987	1.4	0.06		0.9	0.06	2.2	1.00	0.15
1988	2.1	0.21		1.6	0.21	4.3	1.00	0.30
1989	1.4	0.14		1.1	0.14	2.9	1.00	0.20
1990	1.5	0.14		1.1	0.14	2.9	1.00	0.20
1991	1.1	0.11		0.8	0.11	2.2	1.00	0.16
1992	1.8	0.27		1.4	0.27	4.2	1.00	0.29
1993	3.0	0.47		2.5	0.47	7.5	1.00	0.53
1994	2.0	0.24		1.4	0.24	4.5	1.00	0.31
Middle Brook - SFA 5								
TARGET				**1.01**	-	**2.34**		
1986	1.5	0.015		0.76	0.015	2.10	1.00	0.90
1987	1.1	0.019		0.87	0.019	3.11	1.00	0.90
1988	1.3	0.014		0.63	0.014	1.54	1.00	0.66
1989	0.6	0.019		0.46	0.019	2.17	1.00	0.50
1990	1.1	0.013		0.72	0.013	1.74	1.00	0.75
1991	0.8	0.014		0.49	0.014	1.20	1.00	0.51
1992	1.6	0.043		1.14	0.043	3.34	1.00	1.42
1993	2.2	0.087		1.93	0.087	5.11	1.00	2.18
1994	1.8	0.090		1.42	0.090	4.00	1.00	1.71
Biscay Bay River - SFA 9								
TARGET				**1.11**	-	**2.95**		
1986	2.7	0.10		2.18	0.10	6.14	1.00	2.08
1987	1.4	0.11		1.17	0.11	3.52	1.00	1.19
1988	1.8	0.06		1.33	0.06	3.74	1.00	1.27
1989	1.0	0.11		0.83	0.11	2.64	1.00	0.89
1990	1.7	0.07		1.33	0.07	3.78	1.00	1.28
1991	0.4	0.04		0.40	0.04	1.16	1.00	0.39
1992	1.5	0.05		1.39	0.05	3.86	1.00	1.31
1993	1.1	0.12		0.82	0.12	2.67	1.00	0.90
1994	1.6	0.07		1.37	0.07	3.91	1.00	1.33

Table 5.2.3.2 Continued

Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
	Small	Large	Predicted Large	Small	Large			
Grand River[10] (above fishway) - SFA 19								
TARGET[8]				**0.54**	-	**1.1**		
1988	0.70	-		0.74	-	-		1.36
1989	0.60	-		0.45	-	-		0.83
1990	0.62	-		0.44	-	-		0.83
1991	0.44	-		0.35	-	-		0.64
1992	0.19	-		0.14	-	-		0.26
1993	0.13	-		0.10	-	-		0.19
1994	0.17	-		0.16	-	-		0.31
Liscomb River[1] (above falls) - SFA 19								
TARGET[7]				-	-	-		
1985	0.76	0.136		0.68	0.136	1.58	1.00	0.43
1986	1.74	0.225		1.50	0.225	3.20	1.00	0.87
1987	2.43	0.142		2.14	0.142	3.89	1.00	1.05
1988	1.05	0.120		0.91	0.120	1.88	1.00	0.51
1989	0.88	0.146		0.82	0.146	1.84	1.00	0.50
1990	1.57	0.066		1.39	0.066	2.43	1.00	0.66
1991	0.83	0.060		0.76	0.060	1.42	1.00	0.38
1992	0.29	0.039		0.27	0.039	0.57	1.00	0.15
1993	0.26	0.023		0.25	0.023	0.34	1.00	0.09
1994	0.25	0.018		0.25	0.018	0.32	1.00	0.09
Northeast River (Placentia Bay) - SFA 10								
TARGET				**0.22**	-	**0.72**		
1986	0.88	0.039		0.65	0.039	2.49	1.00	3.46
1987	0.35	0.016		0.32	0.016	1.09	1.00	1.52
1988	0.64	0.011		0.45	0.011	1.50	1.00	2.09
1989	0.81	0.015		0.60	0.015	2.00	1.00	2.77
1990	0.70	0.025		0.53	0.025	1.81	1.00	2.51
1991	0.37	0.008		0.35	0.008	1.16	1.00	1.61
1992	0.96	0.046		0.92	0.046	3.16	1.00	4.40
1993	0.98	0.065		0.84	0.065	3.01	1.00	4.18
1994	0.71	0.070		0.67	0.070	2.47	1.00	3.43
Exploits River - SFA 4								
TARGET				**56.7**	-	**95.9**		
1988	9.5	0.15		7.8	0.15	37.0	1.00	0.39
1989	7.6	0.09		7.0	0.09	35.2	1.00	0.37
1990	7.0	0.12		6.1	0.12	30.0	1.00	0.31
1991	5.7	0.10		4.6	0.10	14.7	1.00	0.15
1992	13.5	0.31		12.1	0.31	26.1	1.00	0.27
1993	22.5	0.63		20.5	0.63	33.7	1.00	0.35
1994	17.6	0.92		14.5	0.92	33.7	1.00	0.35

Table 5.2.3.2 Continued

Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
	Small	Large	Predicted Large	Small	Large			
Little River - SFA 11								
TARGET[6]				**0.23**	-	**0.31**		
1988	0.07	0.003		0.07	0.003	0.16	1.00	0.51
1989	0.11	0.005		0.11	0.005	0.25	1.00	0.82
1990	0.16	0.015		0.16	0.015	0.41	1.00	1.34
1991	0.06	0.006		0.06	0.006	0.02	1.00	0.6
1992	0.10	0.021		0.10	0.021	0.17	1.00	0.54
1993	0.17	0.011		0.17	0.011	0.18	1.00	0.60
1994	0.08	0.013		0.08	0.013	0.12	1.00	0.38
Torrent River - SFA 10								
TARGET				**0.87**	-	**1.50**		
1988	2.39	0.04		2.08	0.044	3.99	1.00	2.66
1989	1.51	0.06		1.37	0.060	3.38	1.00	2.25
1990	2.52	0.08		2.30	0.082	3.31	1.00	2.21
1991	1.57	0.07		1.42	0.073	2.64	1.00	1.76
1992	2.82	0.17		2.35	0.169	4.71	1.00	3.14
1993	4.19	0.22		4.01	0.222	8.07	1.00	5.38
1994	3.82	0.33		3.59	0.331	7.86	1.00	5.30
Western Arm Brook - SFA 14A								
TARGET				**0.34**	-	**0.91**		
1988	0.42	0.00		0.25	0.00	0.66	1.00	0.67
1989	0.46	0.00		0.46	0.00	1.31	1.00	1.42
1990	0.32	0.00		0.32	0.00	1.04	1.00	1.14
1991	0.23	0.00		0.23	0.00	0.62	1.00	0.68
1992	0.48	0.01		0.48	0.01	1.37	1.00	1.51
1993	0.95	0.01		0.95	0.01	2.62	1.00	2.88
1994	0.95	0.03		0.95	0.03	2.65	1.00	2.92
Nespiquit River - SFA 15								
TARGET				**0.69**	**1.36**	**9.61**		
1988	4.06	2.70		2.90	2.38	17.9	0.88	1.87
1989	0.97	1.57		0.31	1.24	8.8	0.79	0.92
1990	2.15	1.39		1.59	1.12	8.5	0.80	0.89
1991	2.93	1.29		2.16	1.03	8.2	0.80	0.85
1992	1.97	0.64		1.09	0.34	2.8	0.52	0.29
1993	1.51	1.08		0.84	0.93	6.9	0.85	0.72
1994	0.98	0.89		0.59	0.77	5.7	0.87	0.59

Table 5.2.3.2 Continued

Year	Returns (10^3)			Spawners (10^3)		Eggs (10^6)	Large Spawners/ Large Returns	Eggs/ Target Eggs
	Small	Large	Predicted Large	Small	Large			
<u>Rivière Saint-Jean, Q2</u>								
TARGET					**377**			
1984	0.11	1.12		0.09	0.77	2.98	0.69	0.79
1985	0.06	0.80		0.04	0.47	1.96	0.59	0.52
1986	0.16	0.82		0.09	0.58	2.31	0.71	0.61
1987	0.56	1.07		0.45	0.80	3.34	0.75	0.89
1988	0.43	1.90		0.28	1.31	4.93	0.69	1.31
1989	0.26	1.37		0.16	0.86	3.58	0.63	0.95
1990	0.51	0.78		0.32	0.51	2.19	0.66	0.58
1991	0.43	1.49		0.29	0.98	4.05	0.66	1.07
1992	0.55	1.49		0.26	0.85	3.56	0.57	0.94
1993	0.61	1.10		0.30	0.59	2.49	0.53	0.66
1994	0.48	1.26		0.23	0.68	2.93	0.54	
<u>Rivière Bec-Scie, Q10</u>								
TARGET					**0.234**			
1984	0.05	0.13		0.04	0.07	0.232	0.52	0.99
1985	0.12	0.16		0.09	0.13	0.417	0.79	1.78
1986	0.03	0.09		0.01	0.04	0.165	0.45	0.70
1987	0.13	0.08		0.10	0.06	0.246	0.76	1.05
1988	0.10	0.07		0.08	0.05	0.194	0.64	0.83
1989	0.08	0.13		0.07	0.12	0.438	0.98	1.87
1990	0.14	0.05		0.11	0.05	0.215	0.83	0.92
1991	0.09	0.13		0.08	0.11	0.387	0.83	1.65
1992	0.08	0.08		0.07	0.07	0.26	0.82	1.11
1993	0.10	0.04		0.07	0.03	0.152	0.87	0.65
1994	0.10	0.07		0.08	0.06	0.11	0.90	0.47

[1]Hatchery and wild origin.
[2]Range of estimates provided for Restigouche Rivers in 1990 to 1992.
[3]Prediction does not adjust for increased counts resulting from release of MSW fish from angling.
[4]Small salmon spawners/small salmon returns.
[5]Mean value.
[6]Target for the entire river system (including areas under enhancement).
[7]No targets determined for acid-stressed rivers.
[8]Target for complete river.
[9]Incl. a transfer of 124 female spawners to this river.
[10]All size groups combined.
[11]Prediction is for small salmon return.
[12]Does not include hatchery fish.

Table 5.2.3.3. Estimated numbers of 2SW spawners in North America by geographic regions, 1974-1994

	Labrador		Newfoundland		Gulf of St.Lawrence		Quebec		Scotia-Fundy		USA	Total		
YEAR	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Mid Point
1974	3,883	29,227	368	2,352	32,810	65,904	8,151	24,453	7,701	12,450	1,214	54,126	135,600	94,863
1975	3,958	27,853	381	2,495	19,313	43,088	7,087	21,261	10,127	15,096	2,034	42,900	111,827	77,363
1976	4,407	32,623	281	1,959	15,691	41,304	7,428	22,284	8,482	12,901	1,189	37,478	112,260	74,869
1977	3,459	27,185	159	1,961	34,235	72,521	10,995	32,985	11,088	17,431	1,594	61,530	153,677	107,603
1978	2,855	22,385	98	1,114	12,717	30,291	8,805	26,415	6,267	9,881	3,518	34,261	93,604	63,932
1979	1,609	13,492	129	1,097	4,096	13,374	3,980	11,940	3,936	6,594	1,581	15,332	48,079	31,705
1980	4,317	32,178	106	1,247	21,698	48,929	11,396	34,188	13,018	21,487	4,600	55,134	142,629	98,882
1981	4,095	29,378	168	1,477	5,294	20,025	7,629	22,887	5,605	11,002	4,614	27,405	89,383	58,394
1982	2,714	21,314	60	810	11,779	29,930	8,867	26,601	4,271	7,646	4,994	32,684	91,294	61,989
1983	1,945	14,723	71	1,018	7,903	22,305	5,694	17,082	2,789	5,266	1,790	20,192	62,184	41,188
1984	1,243	10,161	148	928	16,226	35,134	5,814	17,442	10,039	15,922	2,646	36,115	82,233	59,174
1985	1,109	8,499	81	484	22,345	49,678	6,741	20,223	14,267	25,978	4,830	49,372	109,692	79,532
1986	1,975	14,855	191	1,147	35,150	73,865	7,964	23,892	12,876	25,619	5,480	63,636	144,859	104,247
1987	2,461	18,850	201	1,204	21,330	52,408	6,633	19,899	8,526	16,112	2,632	41,783	111,105	76,444
1988	1,476	12,362	166	995	24,777	53,800	8,967	26,901	7,824	16,115	2,809	46,019	112,981	79,500
1989	1,466	11,990	100	600	15,987	36,695	7,615	22,845	9,550	17,931	2,809	37,527	92,870	65,198
1990	799	6,744	160	959	28,759	69,983	8,330	24,990	8,663	16,382	4,298	51,009	123,357	87,183
1991	333	2,490	120	723	20,952	50,714	7,737	23,211	7,313	12,973	2,409	38,865	92,520	65,692
1992	744	7,883	549	3,294	31,553	69,267	8,448	25,344	6,831	12,097	2,403	50,528	120,289	85,409
1993	4,060	16,530	282	1,695	17,974	74,675	6,691	20,073	4,880	8,993	2,104	35,992	124,069	80,030
1994	5,238	22,697	213	1,277	21,564	58,597	10,705	32,115	3,447	7,253	1,308	42,474	123,247	82,861
MEAN	2,578	18,258	192	1,373	20,102	48,214	7,889	23,668	7,976	14,054	2,898	41,636	108,465	75,051

Labrador: SFAs 1&2
Newfoundland: SFAs 3-11
Gulf of St. Lawrence: SFAs12-18
Scotia-Fundy:SFA 19-23(not incl. SFA 22 as does not produce 2SW)
Quebec: Q1-Q11

Table 5.2.3.4 Total run size (all ages) and estimated spawning escapement (including hatchery broodstock) of Atlantic salmon in three USA rivers.

River	Year	Total Run Size: Observed(2) Rod	Trap	Total	Adjusted Total(3)	Spawners (No. MSW Females) Broodstock	Escapement	Females/ Target Females
Penobscot River	1985	325	3,031	3,356	3,972	340	1,060	0.41
(Target: 3,420)	1986	372	4,157	4,529	5,356	310	1,440	0.51
MSW Females(1)	1987	164	2,346	2,510	2,965	353	505	0.25
	1988	168	2,687	2,855	3,371	347	655	0.29
	1989	337	2,750	3,087	3,657	322	650	0.28
	1990	403	2,953	3,356	3,978	334	885	0.36
	1991	181	1,576	1,757	2,080	347	415	0.22
	1992	146	2,233	2,379	2,810	363	285	0.19
	1993	119	1,650	1,769	2,090	318 (5)	340	0.19
	1994	7	1,042	1,049	1,235	215	196	0.12
Merrimack River(4)	1985			214	-	105		0.08
(Target: 1,299)	1986			103	-	53		0.04
MSW Females	1987			139	-	62		0.05
	1988			65	-	33		0.03
	1989			84	-	41		0.03
	1990			248	-	134		0.10
	1991			332	-	218		0.17
	1992			199	-	94		0.07
	1993			61	-	42		0.03
	1994			21	-	10		0.01
Connecticut River(4)	1985			310	-	153		0.03
(Target: 4,863)	1986			318	-	170		0.03
MSW Females	1987			353	-	193		0.04
	1988			95	-	59		0.01
	1989			109	-	57		0.01
	1990			263	-	147		0.03
	1991			203	-	108		0.02
	1992			490	-	270		0.06
	1993			199	-	121		0.02
	1994			326	-	151		0.03

(2)Trap catch and sport harvest below trap.

(3)Penobscot River trap catch adjusted for .85 fish passage efficiency and .80 reporting rate for sport harvest.

(4)Incidental escapements in some years but sex composition unknown.

(5) Includes 63 females that died of "Ich" prior to spawning.

Table 5.2.3.5. 2SW spawning stock size to North America and to each of the geographic areas. Lagged refers to the allocation of spawners to the year in which they would have contributed to the year of prefishery abundance.

	North America		Prefishery	Recruits/	Labrador		Newfoundland		Quebec		Gulf		Scotia		USA	
Year	Total	Lagged	abundance	Spawner	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged	Total	Lagged
74	94865		689188		16555		1361		16302		49357		10076		1214	
75	77365		795276		15906		1438		14174		31201		12612		2034	
76	74870		706814		18515		1120		14856		28498		10692		1189	
77	107604		566179		15322		1060		21990		53378		14260		1594	
78	63932		320904		12620		606		17610		21504		8074		3518	
79	31705		705962		7551		613		7960		8735		5265		1581	
80	98883		619221		18248		677		22792		35314		17253		4600	
81	58395	85501	591253	6.92	16737	15688	823	1229	15258	14984	12660	38479	8304	12843	4614	2277
82	61991	89749	490695	5.47	12014	17300	435	1075	17734	18282	20855	39977	5959	10526	4994	2590
83	41189	62119	270166	4.35	8334	16225	545	772	11388	18429	15104	17353	4028	6421	1790	2918
84	58760	64258	291667	4.54	5702	13387	123	630	11628	13790	25680	19683	12981	12475	2646	4293
85	79533	69446	467162	6.73	4804	10412	283	659	13482	16276	36012	25530	20123	11814	4830	4756
86	104248	59906	499987	8.35	8415	14257	669	751	15928	17624	54508	16581	19248	6945	5480	3748
87	76445	59460	460708	7.75	10656	16519	703	574	13266	16781	36869	18330	12319	4812	2632	2443
88	79501	60632	367376	6.06	6919	13591	581	502	17934	14266	39289	19481	11970	9412	2809	3380
89	65199	73779	300048	4.07	6728	9723	350	278	15230	12227	26341	29486	13741	17217	2809	4849
90	87184	86789	256106	2.95	3772	6783	560	256	16660	12779	49371	43074	12523	19557	4298	4340
91	65693	85513	277135	3.24	1412	5529	422	525	15474	14418	35833	46956	10143	15092	2409	2993
92	85409	75747	177570	2.34	4314	7246	1922	671	16896	14545	50410	38349	9464	12146	2403	2791
93	80031	76244	150470	1.97	10295	9369	989	614	13382	15787	46325	34070	6937	13034	2104	3370
94	82862	77167			13968	8238	745	446	21410	16168	40081	35884	5350	12999	1308	3433
95		80360				6723		487		16129		43319		11100		2602
96		75327				4725		525		16009		42031		9748		2291
97		78266				2653		1347		16117		48365		7950		1835

Table 5.2.4.1 Wild smolt production from monitored rivers in eastern Canada.

River	Years	Range in smolt (counts) output		
		Minimum	Maximum	Magnitude (Max/Min)
Little River (tributary of Stewiacke River SFA 22)	1990 - 1994	1500	4000	2.7 x
Lake O'Law Brook (tributary to Margaree River SFA 18)	1991 - 1994	631	2541	4.0 x
Catamaran Brook (tributary of the Northwest Miramichi SFA 16)	1990 - 1994	515	2429	4.7 x
St. Jean Q2	1989 - 1994	92575	154906	1.7 x
de la Trinité Q7	1984 - 1994	40695	96469	2.4 x
Highlands SFA 13	1980 - 1982, 1993 - 1994	9986	15839	1.6 x
Conne SFA 11	1987 - 1994	55765	74585	1.3 x
Rocky SFA 9	1990 - 1994	5115	9781	1.9 x
Northeast Trepassey SFA 9	1986 - 1994	944	1911	2.0 x
Campbellton SFA 4	1993 - 1994	31577	41633	1.3 x
Western Arm Brook (WAB) SFA 14A	1971 - 1994	5735	20653	3.6 x

Table 6.1.1.1 Nominal catches of SALMON at West Greenland, 1960-1992 (tonnes round fresh weight)

Year	Norway	Faroes	Sweden	Denmark	Greenland[5]	Total	Quota
1960	-	-	-	-	60	60	-
1961	-	-	-	-	127	127	-
1962	-	-	-	-	244	244	-
1963	-	-	-	-	466	466	-
1964	-	-	-	-	1,539	1,539	-
1965	-[1]	36	-	-	825	861	-
1966	32	87	-	-	1,251	1,370	-
1967	78	155	-	85	1,283	1,601	-
1968	138	134	4	272	579	1,127	-
1969	250	215	30	355	1,360	2,210	-
1970	270	259	8	358	1,244	2,146[3]	-
1971	340	255	-	645	1,449	2,689	-
1972	158	144	-	401	1,410	2,113	-
1973	200	171	-	385	1,585	2,341	-
1974	140	110	-	505	1,162	1,917	-
1975	217	260	-	382	1,171	2,030	-
1976	-	-	-	-	1,175	1,175	1,190
1977	-	-	-	-	1,420	1,420	1,190
1978	-	-	-	-	984	984	1,190
1979	-	-	-	-	1,395	1,395	1,190
1980	-	-	-	-	1,194	1,194	1,190
1981	-	-	-	-	1,264	1,264	1,265[5]
1982	-	-	-	-	1,077	1,077	1,253[5]
1983	-	-	-	-	310	310	1,190
1984	-	-	-	-	297	297	870
1985	-	-	-	-	864	864	852
1986	-	-	-	-	960	960	909
1987	-	-	-	-	966	966	935
1988	-	-	-	-	893	893	
1989	-	-	-	-	337	337	900
1990	-	-	-	-	274	274	924
1991	-	-	-	-	472	472	840
1992	-	-	-	-	237	237	-
1993	-	-	-	-	0[2]	0[2]	-
1994	-	-	-	-	0[2]	0[2]	-

[1] Figures not available, but catch is known to be less than the Faroese catch.

[2] The fishery was suspended.

[3] Including 7 t caught on longline by one of two Greenland vessels in the Labrador Sea early in 1970.

[4] For Greenlandic vessels: all catches up to 1968 were taken with set gillnets only; after 1968, the catches were taken with set gillnets and drift nets. All non Greenlandic catches from 1969 1984 were taken with drift nets.

[5] Quota corresponding to specific opening dates of the fishery.

Factor used for converting landed catch to round fresh weight in fishery by Greenland vessels = 1.11.
Factor for Norwegian, Danish, and Faroese drift net vessels = 1.10.

Table 6.1.1.2 Distribution of nominal catches (tonnes) taken by Greenland vessels in 1977 1994 by NAFO divisions according to place where landed.

Div.	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994 [1]
1A	201	81	120	52	105	111	14	33	85	46	48	24	9	4	12	+	0	0
1B	393	349	343	275	403	330	77	116	124	73	114	100	28	20	36	4	0	0
1C	336	245	524	404	348	239	93	64	198	128	229	213	81	132	120	23	0	0
1D	207	186	213	231	203	136	41	4	207	203	205	191	73	54	38	5	0	0
1E	237	113	164	158	153	167	55	43	147	233	261	198	75	16	108	75	0	0
1F	46	10	31	74	32	76	30	32	103	277	109	167	71	48	158	130	0	0
1NK	-	-	-	-	20	18	-	5	-	-	-	-	-	-	-	-	-	-
Total	1,420	984	1,395	1,194	1,264	1,077	310	297	864	960	966	893	337	274	472	237	0	0
East Greenland	6	8	+	+	+	+	+	+	7	19	+	4	-	-	4	5	0	0
Total	1,426	992	1,395	1,194	1,264	1,077	310	297	871	979	966	897	337	274	476	242	0	0

[1] The fishery was suspended

\+ Small catch <0.5t

\- No catch

Table 6.1.2.1. Carlin tag returns from 1SW salmon of Maine origin in West Greenland by year and NAFO division. (99 = NAFO division unknown)

	NAFO Division							
Year	1A	1B	1C	1D	1E	1F	99	TOT
1967	1	10	10	8	3	2	3	37
1969	0	1	3	0	1	0	1	6
1970	10	14	6	7	12	2	7	58
1971	29	34	50	57	58	60	94	382
1972	5	4	35	6	15	5	12	82
1973	5	28	25	16	13	12	32	131
1974	8	75	95	79	32	20	48	357
1975	10	22	16	5	1	3	70	127
1976	13	11	9	3	0	0	3	39
1977	0	1	6	0	1	2	1	11
1978	0	5	2	0	0	0	2	9
1980	0	37	20	9	0	0	6	72
1981	0	17	5	0	0	0	18	40
1982	1	42	1	1	0	2	2	49
1983	0	1	6	0	0	0	0	7
1984	1	9	9	0	1	3	0	23
1985	4	25	7	8	0	5	9	58
1986	1	10	15	17	11	18	0	72
1987	2	30	52	43	29	10	0	166
1988	1	29	24	28	20	4	0	106
1989	4	14	44	22	14	8	0	106
1990	1	2	6	4	2	0	0	15
1991	0	1	15	1	1	1	0	19
1992	0	0	3	0	6	5	0	14
1993	0	1	0	0	1	0	0	2
Unk	2	16	46	8	17	4	5	98
Tot	98	439	510	322	238	166	313	2086

Table 6.1.2.2. Estimated harvest of 1SW salmon of Maine origin in West Greenland by year and NAFO division. (99 = NAFO division unknown)

Year	NAFO Division 1A	1B	1C	1D	1E	1F	99	TOT
1967	6	61	61	49	18	12	18	226
1969	0	91	273	0	91	0	91	545
1970	143	200	86	100	171	29	100	828
1971	186	218	320	365	371	384	602	2446
1972	49	39	345	59	148	49	118	809
1973	46	259	231	148	120	111	296	1212
1974	59	549	696	579	234	147	352	2615
1975	102	225	164	51	10	31	716	1299
1976	510	431	353	118	0	0	118	1529
1977	0	81	483	0	81	161	81	886
1978	0	592	237	0	0	0	237	1066
1980	0	1134	613	276	0	0	184	2207
1981	0	811	238	0	0	0	858	1908
1982	26	1100	26	26	0	52	52	1283
1983	0	70	418	0	0	0	0	488
1984	37	332	332	0	37	111	0	849
1985	101	633	177	203	0	127	228	1469
1986	28	283	424	480	311	509	0	2035
1987	25	377	654	541	365	126	0	2087
1988	22	632	523	610	436	87	0	2309
1989	143	501	1576	788	501	287	0	3797
1990	102	203	610	407	203	0	0	1525
1991	0	94	1403	94	94	94	0	1777
1992	0	0	229	0	457	381	0	1067
1993	0	164	0	0	164	0	0	327
Tot	1585	9080	10472	4892	3812	2696	4051	36589

Table 7.1.1 Results of ratio randomization tests of counts of small and large Atlantic salmon for 1992-1994 (moratorium) compared with 1986-1991 (Pre-moratorium). Number of simulations was 2000.

Category	Observed ratio R_o	Minimum simulated value	Maximum simulated value	Significance level for R_o
Small salmon:				
- All rivers	1.7678	0.4501	1.9052	0.0017
- Northern Peninsula and Eastern	2.3208	0.3994	2.1367	0.0005
- South	0.5432	0.4106	2.1981	0.9685
Large salmon:				
- All rivers	2.7194	0.3024	3.1514	0.0120
- Northern Peninsula and Eastern	3.7604	0.2025	3.6390	0.0005
- South	0.9225	0.3863	1.9498	0.9225

Table 7.1.2 Comparison (t-test) of mean counts of small and large salmon during moratorium years 1992-94 with means for the pre-moratorium period 1986-91. The direction of change in the moratorium means relative to the pre-moratorium means is denoted by + (increase) or - (decrease).

	Small			Large		
River	(+/-)	**t**	**p**	(+/-)	**t**	**p**
SFA 4						
Exploits River	+	3.78	0.0069	+	3.05	0.0185
Gander River	+	3.67	0.0213	+	3.67	0.0213
SFA 5						
Middle Brook	+	3.89	0.0060	+	5.01	0.0015
Terra Nova River (Lower)	+	2.36	0.0505	+	3.16	0.0160
SFA 9						
Biscay Bay River	-	0.41	0.6953	-	0.00	0.9471
Northeast Brook, Trepassey	-	0.71	0.5014	-	1.04	0.3317
Rocky River	-	0.14	0.8946	+	3.87	0.0082
SFA 10						
Northeast River, Placentia	+	2.02	0.0830	+	4.66	0.0023
SFA 11						
Conne River	-	2.83	0.0255	-	1.73	0.1269
SFA 14A						
Torrent River	+	2.02	0.0830	+	3.84	0.0064
Western Arm Brook	+	2.81	0.262	+	4.83	0.0019

Table 7.2.2.1 **Estimation of the numbers of farmed and wild fish saved by the buy out of the Faroes quota and the additional numbers of fish returning to home waters assuming that the full quota would have been taken if the commercial fishery had operated.**

Fishery	Origin	Sea	No.	Estimated returns in 1992			Estimated returns in 1993			Estimated returns in 1994			Estimated returns in 1995		
season		age	saved	1SW	2SW	>2SW	1SW	2SW	>2SW	1SW	2SW	>2SW	1SW	2SW	>2SW
1991/92	Wild	Total	96,648												
		1SW	4,224	3,196	-	-	-	799	-	-	-	-	-	-	-
		2SW	79,805	-	60,380	-	-	-	15,099	-	-	-	-	-	-
		>2SW	12,620	-	-	9,548	-	-	2,388	-	-	-	-	-	-
	Farmed	All	56,761												
Research catch	8,464														
Mean wt (kg)	3.66														
1992/93	Wild	Total	103,147												
		1SW	12,340	-	-	-	9,336	-	-	-	2,335	-	-	-	-
		2SW	62,670	-	-	-	-	47,416	-	-	-	11,857	-	-	-
		>2SW	28,137	-	-	-	-	-	21,289	-	-	5,324	-	-	-
	Farmed	All	38,150												
Research catch	5,415														
Mean wt (kg)	4.06														
1993/94	Wild	Total	153,818												
		1SW	24,611	-	-	-	-	-	-	18,621	-	-	-	4,656	-
		2SW	99,059	-	-	-	-	-	-	-	74,948	-	-	-	18,742
		>2SW	30,148	-	-	-	-	-	-	-	-	22,810	-	-	5,704
	Farmed	All	31,505												
Research catch	2,070														
Mean wt (kg)	3.33														
Total extra	- wild			3,196	60,380	9,548	9,336	48,215	38,775	18,621	77,283	39,991	0	4,656	24,446
	-farmed		126,417												

Returns to homewaters calculated assuming that 78% of farmed fish and of 1SW and 2SW wild fish (and all wild fish >2sw) return in the same year. Survival of fish returning in same year is 97% and of fish returning in the following year 86%.

Table 7.2.3.1 Estimation of the numbers of wild and farmed salmon saved by the buy out of the Faroes fishery and the additional numbers of fish returning to home waters

Season	No. fish landed	Wild (%)	Discards (%)	No. wild fish killed	No. farmed fish killed	CPUE	Est.effort (hook.days (x1000)	Catch expected to have been taken: Total	No. wild	No. farmed	Reduction in numbers of fish killed: Total	No. wild	No. farmed	Extra fish returning to homewaters: Year	No.(wild)
Fishery before quota buy-out:															
1988/89	93,496	*	10.7%	58,401	44,057	71	1,317								
1989/90	111,515	56%	9.4%	67,632	53,139	67	1,664								
1990/91	57,441	58%	14.8%	37,946	27,478	79	727								
Mean 8/89-90/91	87,484	57.0%	11.6%	55,118	41,580	71	1,236								
Fishery after quota buy-out:															
1991/92	8,464	63%	8.8%	5,332	3,132	79		105,191	66,271	38,921	96,727	60,938	35,789	1992	46,106
														1993	11,530
1992/93	5,415	73%	9.4%	3,953	1,462	84		112,452	82,090	30,362	107,037	78,137	28,900	1993	59,119
														1994	14,784
1993/94	2,072	83%	14.4%	1,720	352	43		60,306	50,054	10,252	58,234	48,334	9,900	1994	36,570
														1995	9,145
														Total in 1993	70,648
														Total in 1994	51,353

Returns to homewaters calculated assuming that 78% of all 1SW and 2SW wild fish (and all wild fish >2sw) return in the same year. Survival of fish returning in same year is 97% and of fish returning in the following year 86%.

* Mean value for 1988/89 to 1990/91 applied

Table 8.2.3.1 Maximum and minimum estimates (1,000s) of pre-fishery abundance of maturing and non-maturing 1SW recruits in the North East Atlantic Commission area

Year	Catch (numbers)		Estimated returns 1SW		Estimated returns 2SW		Estimated maturing 1SW		Estimated non-mat. 1SW		Total 1SW recruits	
	1SW	MSW	min	max	min	max	min	max	min	max	min	max
1981	717	971	1,643	4,071	1,697	3,385	1,693	4,197	1442	2,711	3,148	6,895
1982	838	716	1,841	4,298	1,238	2,337	1,897	4,431	1,547	3,154	3,444	7,567
1983	1,211	657	2,725	6,441	1,334	2,717	2,809	6,640	1,333	2,717	4,131	9,340
1984	913	586	1,978	4,760	1,150	2,341	2,039	4,907	1,470	2,765	3,495	7,652
1985	1,148	720	2,284	5,070	1,269	2,383	2,355	5,227	1,690	3,588	4,019	8,796
1986	1,177	792	2,469	5,668	1,458	3,091	2,545	5,843	1,336	2,731	3,860	8,552
1987	963	638	2,161	5,194	1,154	2,353	2,228	5,355	1,288	2,494	3,479	7,825
1988	1,137	606	2,145	4,889	1,110	2,147	2,211	5,040	1,065	1,964	3,258	6,980
1989	912	429	2,149	5,293	919	1,692	2,215	5,457	999	2,030	3,173	7,454
1990	637	411	1,485	3,887	863	1,749	1,530	4,007	866	1,745	2,359	5,718
1991	501	339	1,272	3,211	747	1,502	1,312	3,310	930	2,029	2,208	5,307
1992	611	300	1,674	4,318	800	1,745	1,726	4,452	908	1,908	2,574	6,312
1993	576	253	1,476	3,713	781	1,641	1,521	3,827	868	1,936	2,345	5,728
1994	659	271	1,672	4,087	746	1,665	1,723	4,214	0	0	1,685	4,199

Table 8.2.3.2 Maximum and minimum estimates (1,000s) of pre-fishery abundance of maturing and non-maturing 1SW recruits in Southern European Countries (UK, Ireland, France)

Year	Catch (numbers)		Estimated returns 1SW		Estimated returns 2SW		Estimated maturing 1SW		Estimated non-mat. 1SW		Total 1SW recruits	
	1SW	MSW	min	max	min	max	min	max	min	max	min	max
1981	436	504	1,196	3,121	947	2,310	1,233	3,218	710	1,673	1,943	4,891
1982	612	323	1,515	3,578	610	1,439	1,561	3,689	778	2,094	2,339	5,783
1983	846	276	2,154	5,231	661	1,801	2,221	5,393	570	1,637	2,791	7,030
1984	544	201	1,387	3,495	491	1,408	1,430	3,603	703	1,716	2,133	5,319
1985	749	330	1,665	3,714	605	1,476	1,717	3,829	824	2,370	2,541	6,199
1986	809	343	1,894	4,433	709	2,038	1,953	4,571	653	1,768	2,606	6,339
1987	601	286	1,647	3,969	562	1,521	1,698	4,091	760	1,762	2,458	5,854
1988	817	366	1,644	3,814	654	1,516	1,695	3,932	513	1,271	2,208	5,203
1989	581	211	1,537	3,873	441	1,093	1,585	3,992	446	1,185	2,031	5,177
1990	344	168	943	2,642	384	1,019	972	2,724	373	865	1,345	3,589
1991	251	157	712	2,054	321	744	734	2,118	435	1,057	1,170	3,175
1992	381	162	1,087	3,180	374	909	1,121	3,279	386	994	1,507	4,273
1993	356	123	964	2,732	332	855	994	2,816	436	1,105	1,430	3,921
1994	450	141	1,175	3,089	375	950	1,211	3,184	0	0	1,211	3,184

Table 8.2.3.3 Maximum and minimum estimates (1,000s) of pre-fishery abundance of maturing and non-maturing 1SW recruits in Northern European Countries (Scandinavia, Finland, Russia, Iceland)

Year	Catch (numbers)		Estimated returns 1SW		Estimated returns 2SW		Estimated maturing 1SW		Estimated non-mat. 1SW		Total 1SW recruits	
	1SW	MSW	min	max	min	max	min	max	min	max	min	max
1981	281	467	447	950	750	1,075	461	979	732	1,038	1193	2,017
1982	226	393	344	756	635	898	354	779	778	1,060	1,132	1,839
1983	365	381	570	1,210	673	916	588	1,248	762	1,081	1,350	2,328
1984	369	385	591	1,265	659	933	609	1,304	767	1,049	1,376	2,353
1985	398	390	619	1,356	664	907	638	1,398	866	1,218	1,504	2,616
1986	367	450	574	1,234	750	1,052	592	1,273	683	963	1,275	2,235
1987	362	353	514	1,226	592	833	530	1,264	527	732	1,057	1,996
1988	320	240	501	1,075	456	632	516	1,108	552	693	1,068	1,801
1989	330	217	612	1,421	477	599	630	1,465	553	845	1,184	2,309
1990	294	243	542	1,245	480	730	559	1,283	493	880	1,051	2,163
1991	250	181	560	1,157	426	758	577	1,193	494	972	1,072	2,164
1992	230	137	587	1,138	425	836	605	1,173	521	913	1,127	2,087
1993	220	130	512	981	448	786	528	1,011	431	831	959	1,843
1994	209	130	497	999	371	715	512	1,029	0	0	512	1,029

Table 9.1.2.1 Input data for 1994 run reconstruction estimates
Summary of catch and returns (numbers) by size class (Small, Large) for Canada. Partitioning of catches by Salmon Fishing Area (SFA) is related to known migration patterns of 1SW salmon and to availability of grilse return estimates.

		NonMat 1SW Component		Mat 1SW Component		Grilse Returns		2SW Catches		Total 2SW Returns	
	{SFA}	{1-7, 14b}		{3-7,14a}		{3-7, 14a}		{1-7, 14b}	{8-14a}	North America	
Year	Grld Catch	H_Small	H_Large	H_Small	H_Large	Min	Max	H_Large	H_Large	Min	Max
(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i)	(i+1)	(i+1)	(i+1)	(i+1)
1974	220584	192195	196726	145350	75500	35417	70833	215025	72814	103752	187046
1975	278839	302348	215025	201591	102975	42618	85237	210858	95714	106249	200755
1976	155896	221766	210858	160999	81405	51136	102272	231393	63449	149912	272147
1977	189709	220093	231393	159768	118236	64338	128675	155546	37653	100135	179759
1978	118853	102403	155546	77624	66104	50719	101438	82174	29122	47570	89328
1979	200061	186558	82174	160441	31538	55665	111330	211896	54307	146094	261829
1980	187999	290127	211896	200522	89972	56961	113922	211006	38663	93664	176876
1981	227727	288902	211006	190232	101407	81738	163477	129319	35055	102022	184157
1982	194715	222894	129319	161426	48010	63518	127035	108430	28215	84372	150284
1983	33240	166033	108430	132708	50363	54047	108093	87742	15135	73594	130518
1984	38916	123774	87742	104218	46638	58724	117448	70970	24383	91137	162238
1985	139233	178719	70970	140635	37798	67612	135223	107561	22036	112116	208924
1986	171745	222671	107561	164520	52625	61501	123002	146242	19241	85665	166089
1987	173687	281762	146242	217549	70785	63850	127700	86047	14763	91585	172230
1988	116767	198484	86047	138316	39785	70071	140142	85319	15577	78084	146189
1989	60693	172861	85319	128838	40279	28851	57702	59334	11639	87950	172052
1990	73109	104788	59334	80383	32597	46545	93090	39257	10259	75390	138097
1991	110680	89099	39257	69890	26465	33839	67678	26591	0	79063	150639
1992	41764	20188	26591	0	0	86965	173930	17096	0	58565	150579
1993	0	17074	17096	0	0	94162	188323	15213	0	77089	162743
1994	0	8508	15213	0	0	67788	135575	---	---	---	---
	[G1]							[H_L(1-7)]	[H_L(8-14)]	[R2_min]	[R2_max]

Table 9.1.2.2. Summary of estimated catch and return data by sea age class for Canada. See text and designated equations for details on computation.

	{SFA 1-7, 14a}		{SFA 3-7, 14a}		{SFA 3-7, 14a}		{SFA 1-13, 14a, 14b}		{all North America}			Pre-fishery nonmaturing	
Year	1SW Non Maturing (i)		1SW Maturing (i)		Grilse Returns (i)		2SW Harvest (i+1)		2SW Returns (i+1)			1SW abundance (N. A.)	
(i)	min	max	min	max	min	max	min	max	min	max		min	max
1974	21187	50243	122320	151200	35417	70833	223332	266337	103752	187046		604406	773969
1975	32385	73371	169511	209235	42618	85237	243315	285486	106249	200755		698732	891820
1976	24285	57005	135312	166878	51136	102272	225424	271703	149912	272147		596657	816970
1977	24323	57902	137273	175715	64338	128675	146535	177644	100135	179759		487757	644600
1978	11796	29813	67388	87710	50719	101438	86644	103079	47570	89328		279507	362300
1979	19478	42242	130876	152912	55665	111330	202634	245013	146094	261829		606566	805358
1980	31132	70739	167615	204762	56961	113922	186367	228568	93664	176876		529653	708788
1981	31000	70441	160298	198589	81738	163477	125578	151442	102022	184157		511398	671107
1982	23583	52338	132982	158246	63518	127035	104116	125802	84372	150284		427546	553844
1983	17688	39712	110195	133035	54047	108093	76554	94103	73594	130518		217685	322646
1984	13255	30019	87105	106388	58724	117448	74062	88256	91137	162238		235756	347577
1985	18582	40002	115532	136777	67612	135223	97329	118841	112116	208924		390532	543792
1986	23343	50988	135826	162277	61501	123002	121610	150859	85665	166089		425114	574859
1987	29639	65127	179702	214906	63850	127700	74996	92205	91585	172230		388443	532973
1988	20709	44860	113836	135226	70071	140142	75300	92364	78084	146189		307859	426892
1989	18139	39691	106293	126830	28851	57702	53173	65040	87950	172052		235774	364322
1990	11072	24518	66914	81146	46545	93090	37739	45590	75390	138097		210046	302166
1991	9302	20175	58029	70047	33839	67678	18614	23932	79063	150639		228810	325459
1992	2285	5633	0	0	86965	173930	11967	15386	58565	150579		122649	232490
1993	1878	4441	0	0	94162	188323	10649	13692	77089	162743		99701	201239
1994	1003	2614	0	0	67788	135575	---	---	---	---		---	---
	{Eq.7}	{Eq.6}	{Eq.23}	{Eq.22}			{Eq.16}	{Eq.17}					
	[C1_min]	[C1_max]			[R1_min]	[R1_max]	[C2_min]	[C2_max]	[R2_min]	[R2_max]		[N1_min]	[N1_max]

[N1_min] = ([R2_min] / S1 + [C2_min]) / S2 + [C1_min] + [G1]

[N1_max] = ([R2_max] / S1 + [C2_max]) / S2 + [C1_max] + [G1]

where S1=exp(-0.12*2/12) and S2=exp(-0.12*10/12)

Table 9.1.3.1 Thermal habitat derived from OI and blended analyses for March and for the sum of (January + February + March).

Year	Prefishery Abundance Mid-point	OI March	Blend March	% Diff (Blend-OI)	OI for Jan+Feb+Mar	Prefishery abundance OI from Jan+Feb+Mar Unbiased Predicted	Prefishery abundance OI from Jan+Feb+Mar Unbiased Residual
74	689188	1746	1746		5534	562294	126894
75	795276	1842	1842		5430	505968	289308
76	706814	1953	1953		5424	533307	173507
77	566179	1994	1994		5689	609952	-43772
78	320904	1979	1979		5822	761988	-441084
79	705962	1999	1999		5982	664701	41261
80	619221	2088	2088		5710	610182	9039
81	591253	1806	1806		5464	555599	35654
82	490695	1621	1778	9	5124	482746	7949
83	270166	1369	1628	16	4311	308158	-37992
84	291667	1209	1372	12	3902	201769	89898
85	467162	1397	1469	5	4178	240950	226212
86	499987	1547	1698	9	5067	469771	30217
87	460708	1471	1521	3	4809	412789	47919
88	367376	1622	1731	6	5067	474788	-107412
89	300048	1552	1645	6	5001	466486	-166438
90	256106	1491	1567	5	4520	357093	-100986
91	277135	1519	1484	-2	4279	300145	-23010
92	177570	1378	1374	-0	4233	301257	-123687
93	150470	1242	1328	6	3935	236110	-85640
94		1373	1393	1	4189		
95		1279			4033		

Table 9.1.3.2. Thermal habitat values (OI analysis) for the northwest Atlantic Ocean, 1970-95.

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
1970	2046	1899	1901	1870	2097	2289	2126	1599	1778	2133	2116	2055
1971	2049	2011	1819	1894	2034	2103	2022	1554	1694	2060	2054	1967
1972	2034	1990	1914	1793	1829	2126	2244	2002	1826	1855	1898	1866
1973	2007	1708	1896	1792	2026	2210	2269	1736	1833	2215	2174	1890
1974	1926	1862	1746	1834	2055	2256	2593	1900	1924	2161	2086	1952
1975	1761	1827	1842	1764	1899	2336	2069	1577	1810	2184	2096	2080
1976	1795	1676	1953	1689	1972	2328	2568	1836	1691	2059	2079	1989
1977	1780	1915	1994	1927	2340	2095	1987	1706	2007	2185	2157	2068
1978	1892	1951	1979	1907	2058	2171	2099	1737	1944	2208	2089	1955
1979	1925	2058	1999	1938	2007	2426	2092	1503	1788	2150	2157	1932
1980	1799	1823	2088	1760	2079	2164	2058	1580	2225	2251	2336	2071
1981	1746	1912	1807	1663	2069	2532	2029	1616	1679	1941	2007	2033
1982	1800	1703	1621	1662	1796	2188	2198	1760	1833	2064	1969	1681
1983	1526	1416	1369	1424	1649	1810	1619	1776	1793	1845	1768	1577
1984	1436	1257	1209	1338	1467	1766	1935	1656	1685	2010	1805	1589
1985	1371	1410	1397	1508	1690	2097	2427	2062	2297	2557	2180	1967
1986	1832	1688	1547	1674	1880	2366	2346	1778	1674	2312	1990	1757
1987	1711	1627	1471	1658	1655	1754	1896	1519	1784	2186	1974	1848
1988	1747	1698	1622	1676	1864	2022	2098	1797	1820	2188	2271	1992
1989	1807	1642	1552	1552	1665	1985	2091	1710	1872	1860	1874	1744
1990	1526	1503	1491	1318	1543	1747	2410	2070	1999	1991	1925	1656
1991	1403	1357	1519	1529	1592	2050	2483	2329	2282	2403	2042	1706
1992	1474	1381	1378	1395	1582	1891	2291	2437	2250	2233	1852	1624
1993	1441	1252	1242	1353	1517	1923	2309	1918	1993	2162	1966	1556
1994	1487	1329	1373	1403	1711	1955	2447	2060	2126	2164	2268	1720
1995	1444	1310	1279									

Table 9.1.4.1 Estimate of pre-fishery abundance in 1995 forecasted by regression model of probability levels between 25 and 75%

Cumulative Density Function %	Forecast
25	154,000
30	175,000
35	193,000
40	211,000
45	229,000
50	244,000
55	262,000
60	280,000
65	298,000
70	316,000
75	337,000

Table 9.1.5.1. Atlantic salmon projection model, initial values of stages in 000s. Software functions: pos(x)=function which replaces a negative values with 0 if x < 0, min(minimum value, x) = replaces x with minimum value if value is less than x, max (maximum value, x) = replaces x with maximum value if value is less than x

Stage:	Stage Name:	Initial Value	Formula
egg/fry	fry:	1158000	2.337 * [sescape] * exp(-.004529 * [sescape]) * 6000
age 1 parr	parr1:	115800	[fry] * pos([p1])
age 2 parr	parr2:	17370	[parr1] * pos([p2])
age 3 parr	parr3:	3474	[parr2] * pos([p3])
age 4 parr	parr4:	869	[parr3] * pos([p4])
smolt	smolts:	4000	[parr1] * pos([s1]) + [parr2] * pos([s2]) + [parr3] * pos([s3]) +[parr4] * pos([s4])
1SW salmon	onesea:	466	[smolts] * min(.223,max(.03,pos([pssur]))) * {.6, 1, 1.05, 1.1, 1.2, 1.3}
escapement 2SW salmon	sescape:	194	[onesea] - pos([onesea] - 187)

Table 9.1.5.2. Atlantic salmon projection model driver functions. All divers are sampled from normal distributions with mean and variance as listed.

Driver	Mean	Variance	Autocorrelation
pssur	0.11648	0.0020313	0.75
p1	0.1	0.000025	
p2	0.15	0.000056	
p3	0.2	0.0001	
p4	0.25	0.000156	
s1	0.0107	0.00000029	
s2	0.129	0.000042	
s3	0.138	0.000048	
s4	0.045	0.0000051	

Table 9.1.6.1 Quota options (in tonnes) for 1995 at West Greenland based on regression forecasts of fishery abundance. Proportion at West Greenland refers to the fraction of harvestable surplus allocated to the West Greenland fishery. The probability level refers to the pre-fishery abundance levels derived from the probability density function.

Prob.	Proportion at West Greenland (Fna)										
level	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
25	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0
40	0	2	3	5	6	8	9	11	12	14	15
45	0	11	22	34	45	56	67	78	89	101	112
50	0	19	38	58	77	96	115	135	154	173	192
55	0	29	58	87	116	145	173	202	231	260	289
60	0	39	77	116	154	193	231	270	309	347	386
65	0	48	96	145	193	241	289	338	386	434	482
70	0	58	116	174	232	290	347	405	463	521	579
75	0	69	138	208	277	346	415	484	554	623	692

Sp. res =	208,170
Prop NA =	0.54
WT1SWNA =	2.525
WT1SWE =	2.66
ACF =	1.121

Table 9.2.2.1 Estimated Atlantic salmon spawner requirements (2SW) for USA rivers[1] .

		Units of salmon habitat ($100m^2$)				Required Spawners (2SW)		
State	**River**	**Existing Habitat Units**	**(%)**	**Potential Habitat Units**	*****	**(%)**	**Existing**	**Potential**
Connecticut	Connecticut	145,900	33.3	261,400		35.2	9,727	17,427
Rhode Island	Paucatuck	5,370	1.2	5,370		0.7	367	367
New Hampshire	Merrimack	38,980	8.9	57,065		7.7	2,599	3,804
Maine	Aroostook	60,775	13.9	60,775	*	8.2	4,052	4,052
	Prestile	835	0.2	835	*	0.1	56	56
	Meduxnekeag	5,000	1.1	5,000	*	0.7	333	333
	St. Croix	29,260	6.7	29,260	*	3.9	1,951	1,951
	Boyden Str.	85	0	85	*	0	6	6
	Pennamaquaun	85	0	85	*	0	6	6
	Dennys	2,415	0.6	2,415		0.3	161	161
	Hobart Str.	85	0	85	*	0	6	6
	Orange	20	0	20	*	0	1	1
	East Machias	2,145	0.5	2,145		0.3	143	143
	Machias	6,685	1.5	6,685	*	0.9	446	446
	Chandler	85	0	85	*	0	6	6
	Indian	85	0	85	*	0	6	6
	Pleasant	1,085	0.2	1,085	*	0.1	72	72
	Narraguagus	6,015	1.4	6,015		0.8	401	401
	Tunk Str.	585	0.1	585	*	0.1	39	39
	Union	8,360	1.9	8,360	*	1.1	557	557
	Orland River	165	0	165	*	0	11	11
	Penobscot	102,575	23.4	102,575	*	13.8	6,838	6,838
	Passaga'wa'kg	165	0	165	*	0	11	11
	Little	0	0	0	*	0	0	0
	Ducktrap	585	0.1	585	*	0.1	39	39
	St. George	250	0.1	250	*	0	17	17
	Medomak	0	0	0	*	0	0	0
	Pemaquid River	85	0	85	*	0	6	6
	Sheepscot River	2,845	0.7	2,845		0.4	190	190
	Kennebec River(4)	1,005	0.2	114,300	*	15.4	67	7,620
	Androscoggin River(	3,175	0.7	47,900	*	6.5	212	3,193
	Royal River	420	0.1	420	*	0.1	28	28
	Presumpscot River	85	0	85	*	0	6	6
	Saco River	12,540	2.9	25,080		3.4	836	1,672
	Mousam River	0	0	0	*	0	0	0
	Kennebunk River	85	0	85	*	0	6	6
	Salmon Falls River	0	0	0	*	0	0	0
	Total Maine	247,585	56.5	418,145	*	56.3	16,506	27,876
USA	**Grand Total**	437,835	100	741,980	*	100	29,198	49,474

[1] Based upon: 240 eggs/unit; 7,200 eggs/female; 50-50 sex ratio

* indicates not all habitat has been inventoried and some inventories are outdated/incomplete.

Table 11.1. Number of microtags, external tags and finclips applied to Atlantic salmon by countries for 1994.

Country	Stock	Micro tags[3]	External tags	Untagged fish		Comments
				Adipose clip only	Other finclip combinations	
Canada	H[1]	--	22,036*	1,356,236	--	* Includes adults
	W[2]	--	12,803*	1,282	--	
Denmark	H	--	--	--	--	No releases of salmon in 1994
	W	--	--	--	--	
Finland	H	--	--	--		No releases of salmon in 1994
	W	--	--	--		
France	H	16,291	1,130	173,765		
	W	94*	432	--		* PIT tags
Iceland	H	388*	288,276	10,000	--	* adults
	W		6,191	--	--	
Ireland	H	249,060	--	213,385	--	
	W	20,106	--	1,500	--	
Norway	H	--	106,103*	66,426	--	* Includes 2,498 adults
	W	--	3,788**	--	--	** Includes 1,292 adults
Russia	H	--	4,649	353,200	--	
	W	--	--	--	--	
Spain	H	115,100	--	6,650*	--	* includes coldbranded fish
	W	--	--	--	--	
Sweden (West coast)	H	--	9,510	26,216	--	
	W	--	388*	--	--	* Includes 58 adults
UK (England & Wales)	H	234,009	--	6,000	--	
	W	117,116	2,566	--	--	
UK (Scotland)	H	7,810	--	--	--	
	W	17,219	6,845*	--	--	* Includes 288 floytagged or radiotagged adults
UK (N. Ireland)	H	8,113	--	--	--	
	W	2,008	299*	--	--	* Includes wild and hatchery reared adults
USA	H	655,646	1,283	119,198	--	
	W	--	250*	--	--	* Includes 5 adults
Total	H	1,286,417	432,987	2,331,076	--	**4,050,480**
	W	156,543	32,842	2,782	--	**192,167**
GRAND TOTAL		**1,442,960**	**465,829**	**2,333,858**	--	**4,242,647**

[1] Hatchery origin
[2] Wild origin
[3] Micro- tagged fish are also adipose clipped unless otherwise noted

Figure 2.1.1 Nominal catches of salmon in four North Atlantic regions 1960-94

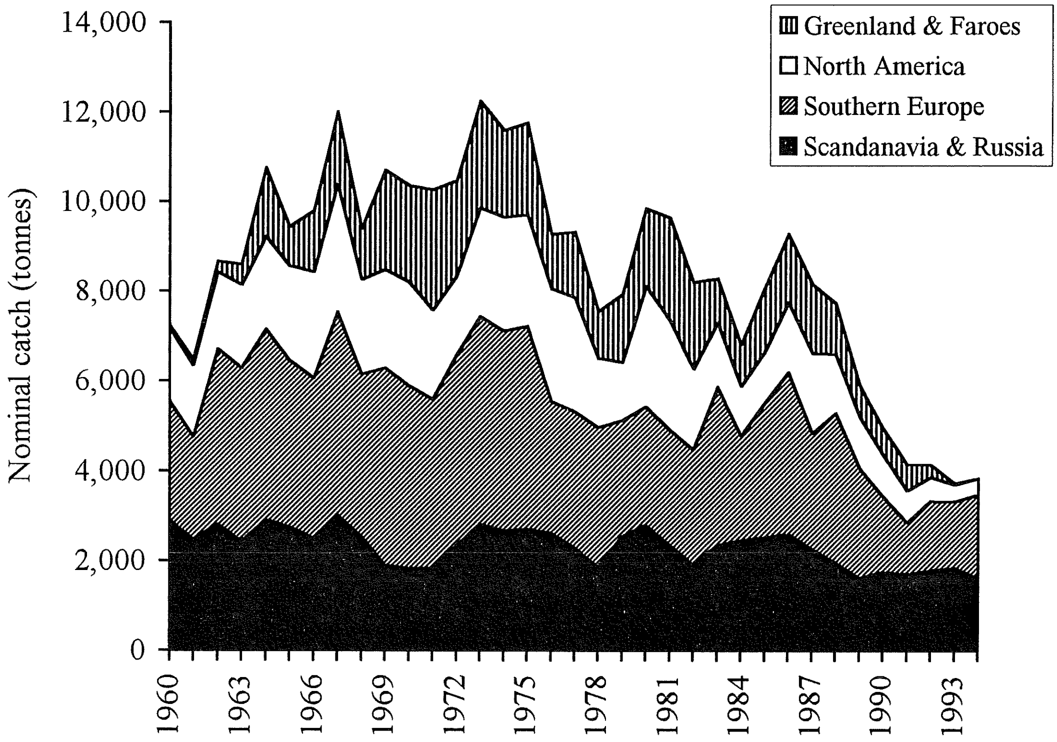


Figure 3.1.1 Production of farmed salmon (tonnes round fresh weight) in the North Atlantic, 1980-1994

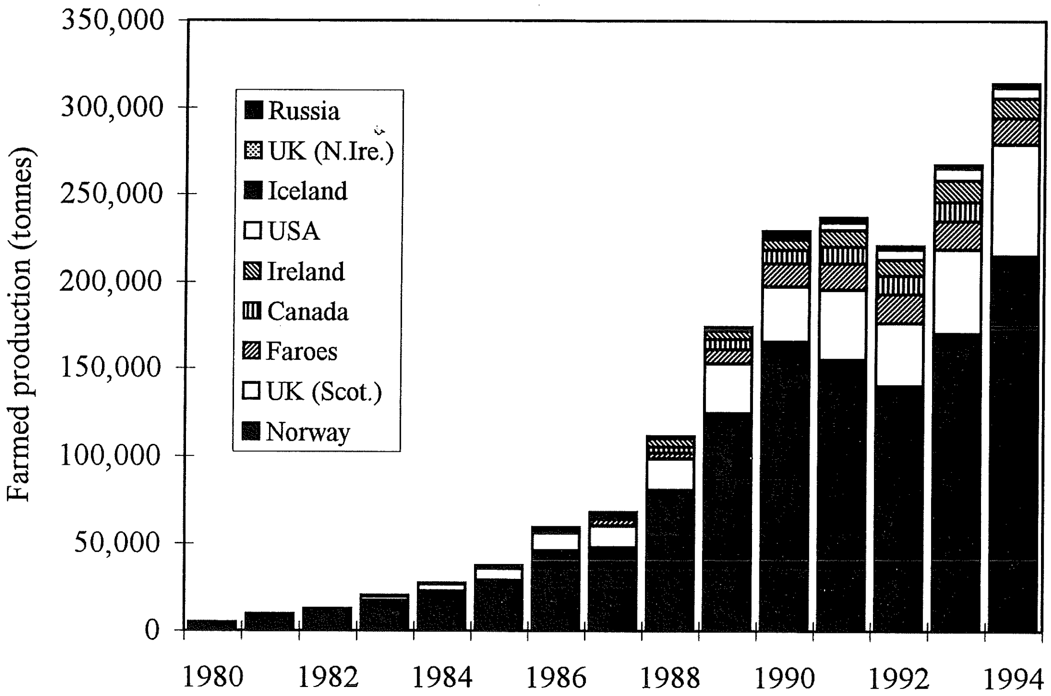
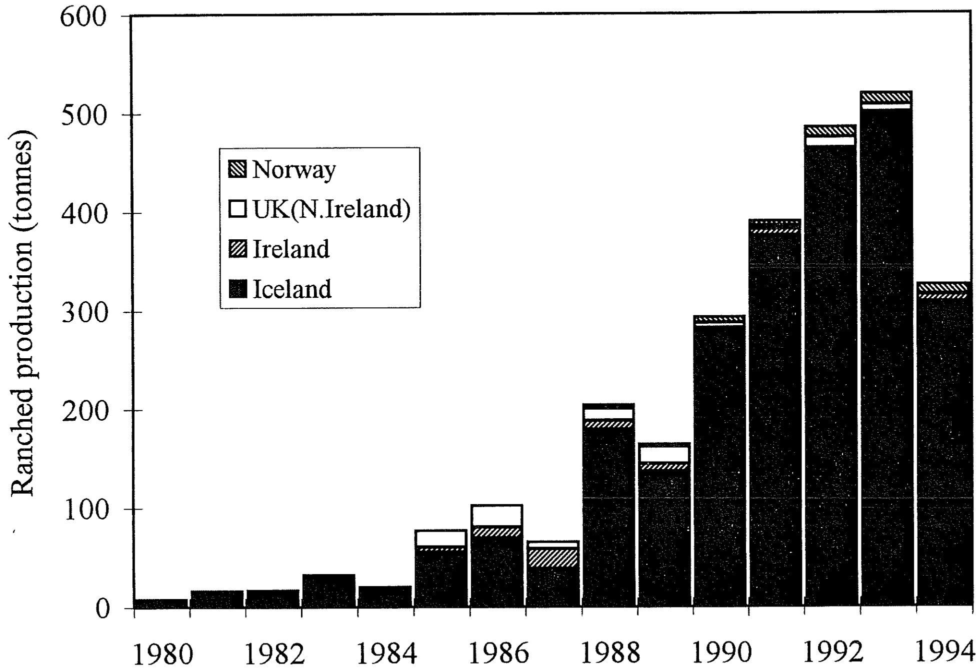


Figure 3.2.1 Production of ranched salmon (tonnes round fresh weight) in the North Atlantic, 1980-1994



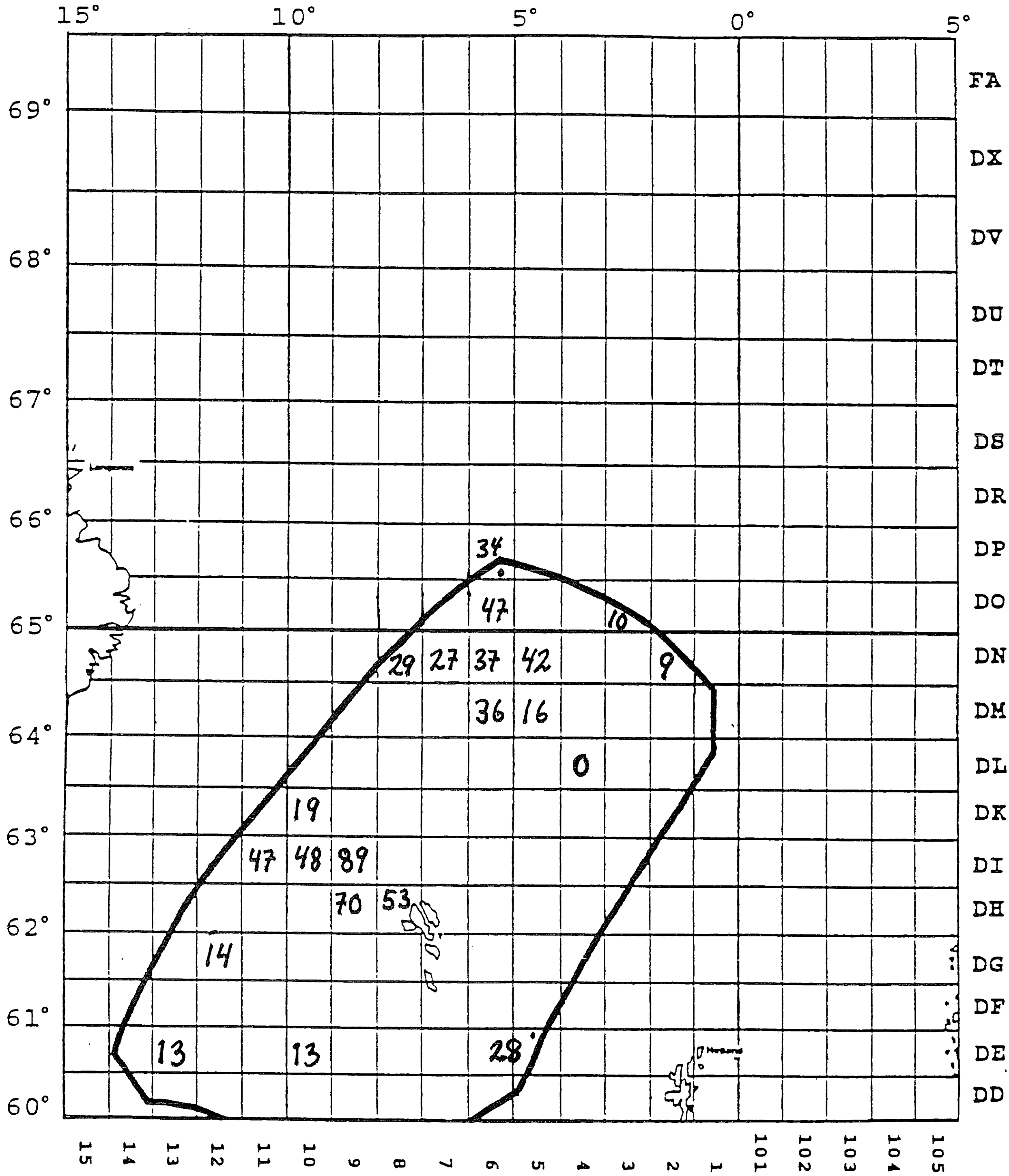


Figure 4.1.3.1. The Faroese EEZ and catch per 1000 hooks (CPUE) by statistical rectangle in the 1993/1994 fishing season.

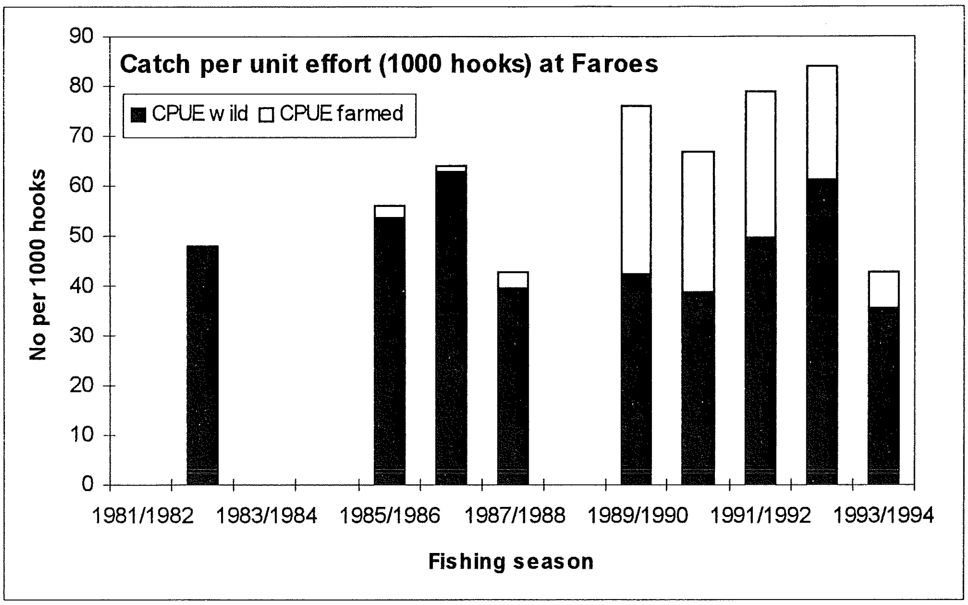


Figure 4.1.3.2. Catch per 1000 hooks (CPUE) in the Faroese fishery inside the EEZ since the 1982/83 fishing season. The catch is broken into wild and farmed fish. The seasons 1981/1982, 1983/1984 and 1984/1985 are not analysed yet.

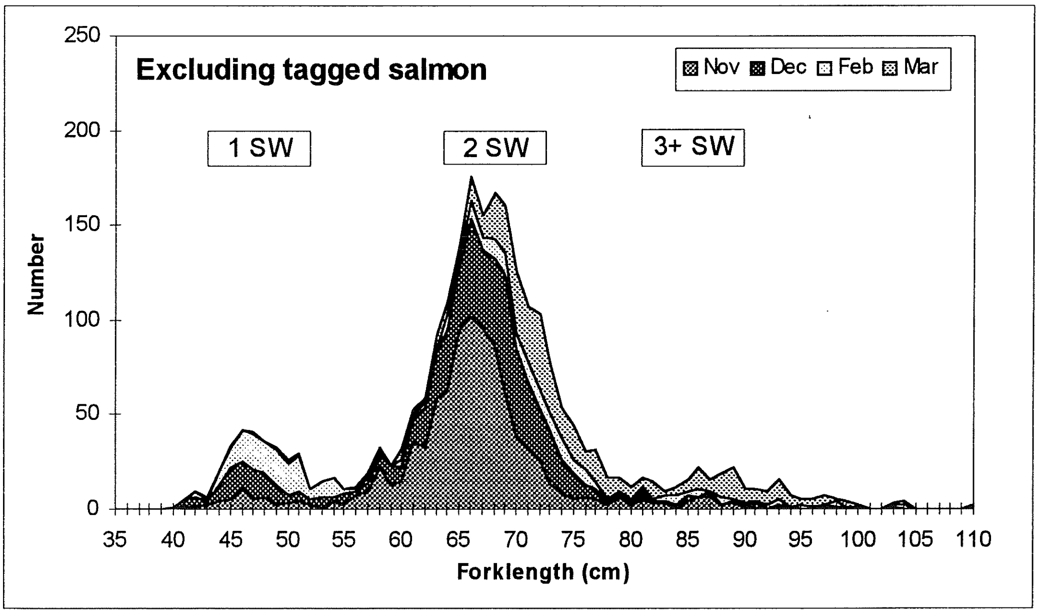


Figure 4.1.4.1. Forklength distribution of salmon sampled at Faroes in the 1993/1994 season by month. Wild and reared fish combined. Sea-age groups are indicated also based on length splits.

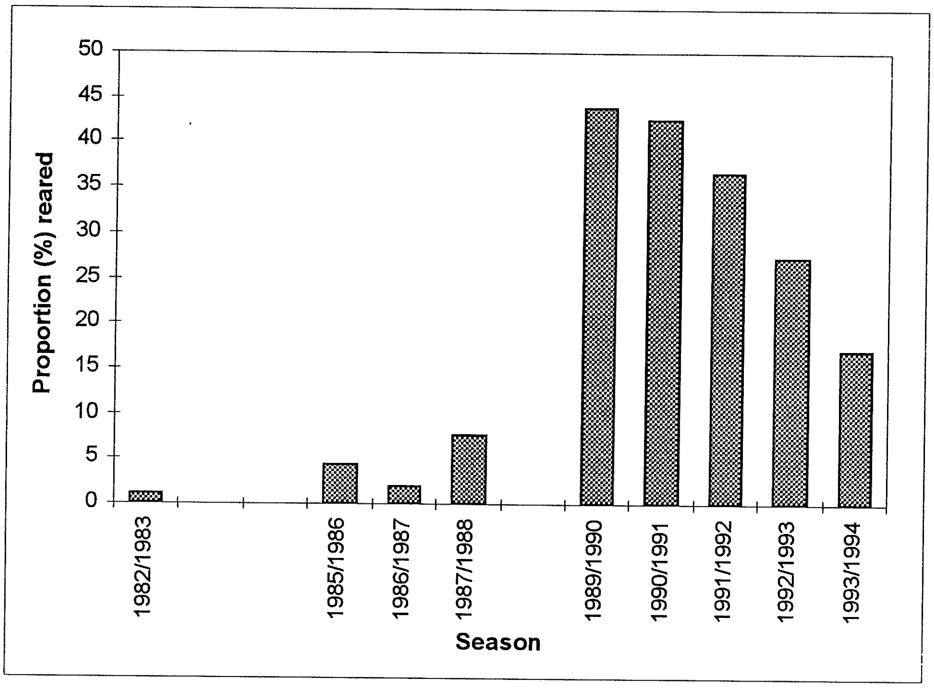


Figure 4.1.4.2. Proportion of fish farm escapees from scale samples collected in the Faroese fishery since the 1982/1983 season.

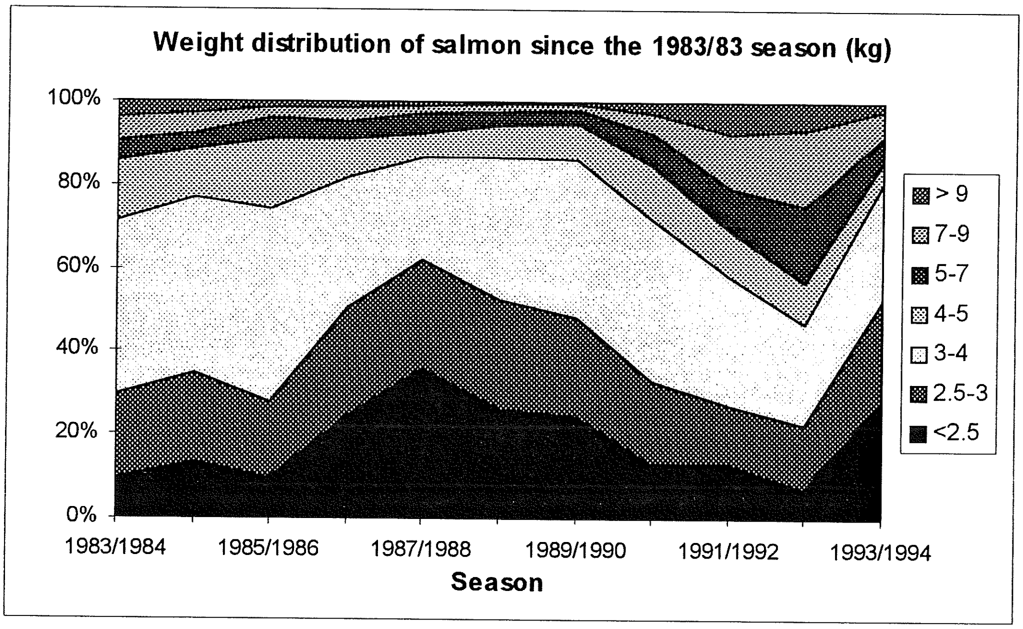


Figure 4.1.4.3. Percentage distribution by weight category (kg) of salmon landed in the Faroese fishery since the 1983/84 fishing season.

Figure 5.1.1 Map of Salmon Fishing Areas (SFAs) in Canada

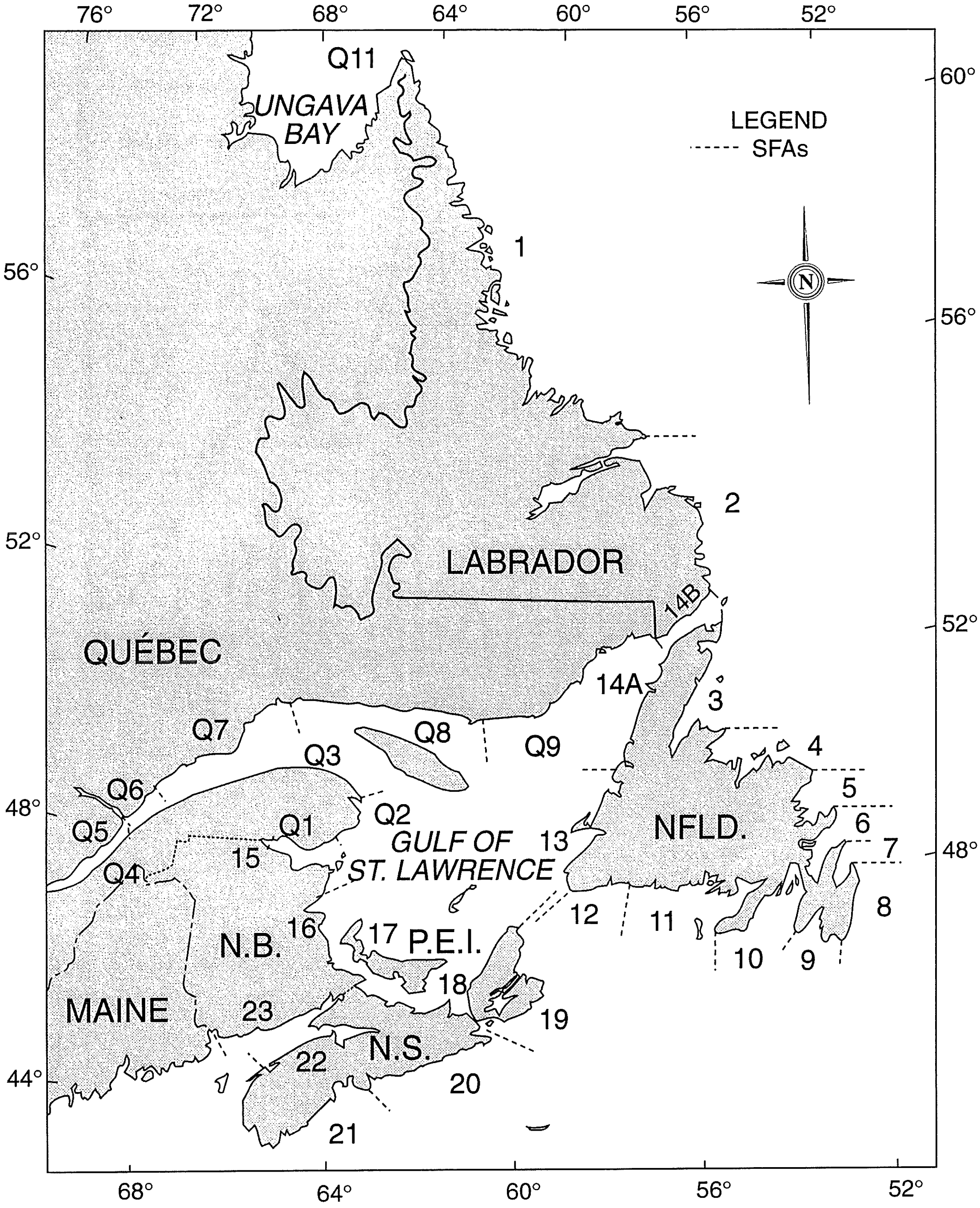


Fig. 5.1.2.1. Harvests (t) of small and large salmon for 1970 to 1994, and total harvests from Atlantic Canada for 1960 to 1994.

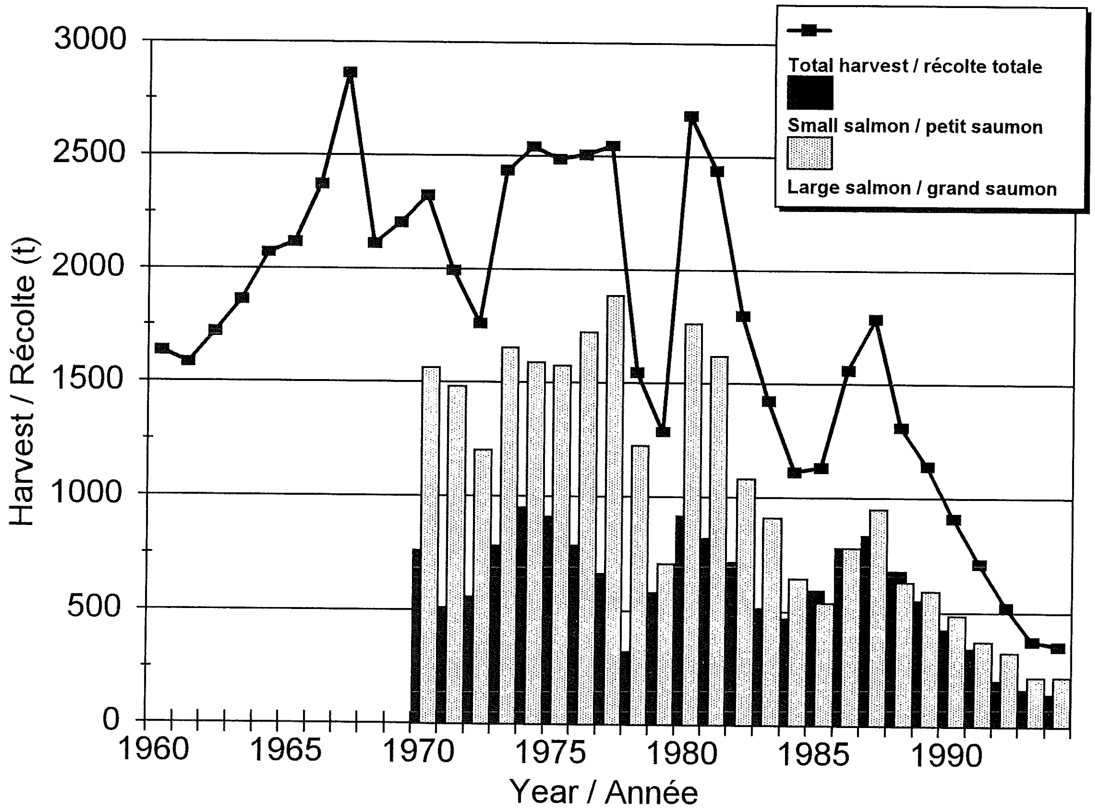
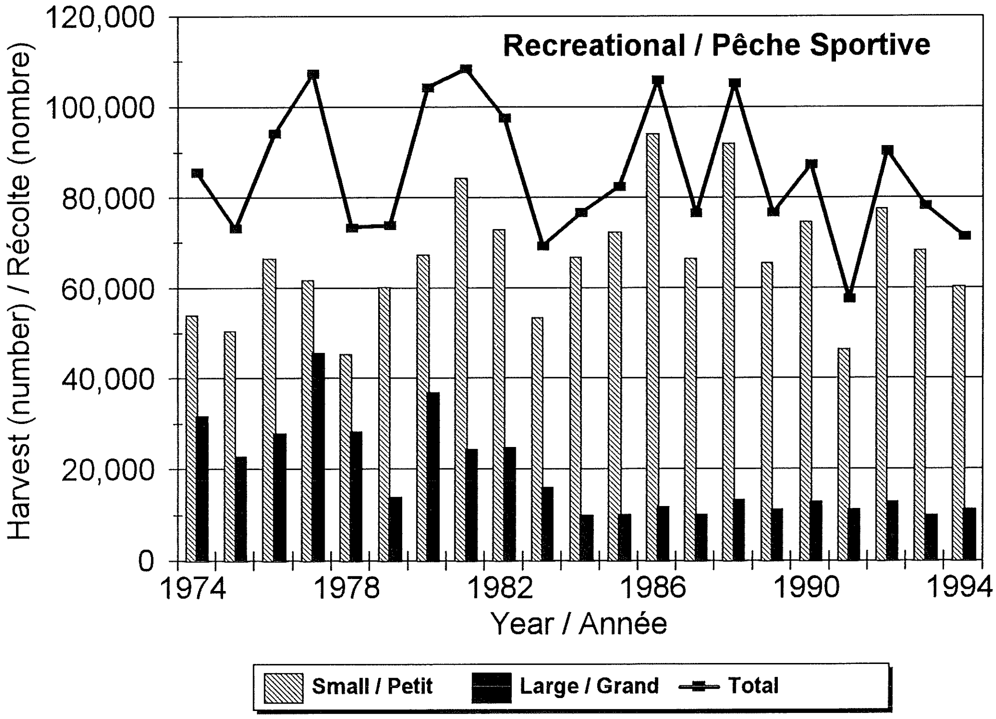


Figure 5.1.2.2. Recreational harvest (number of fish) and commercial harvest (t) of small salmon, large salmon and sizes combined for Atlantic Canada in 1974 to 1994.



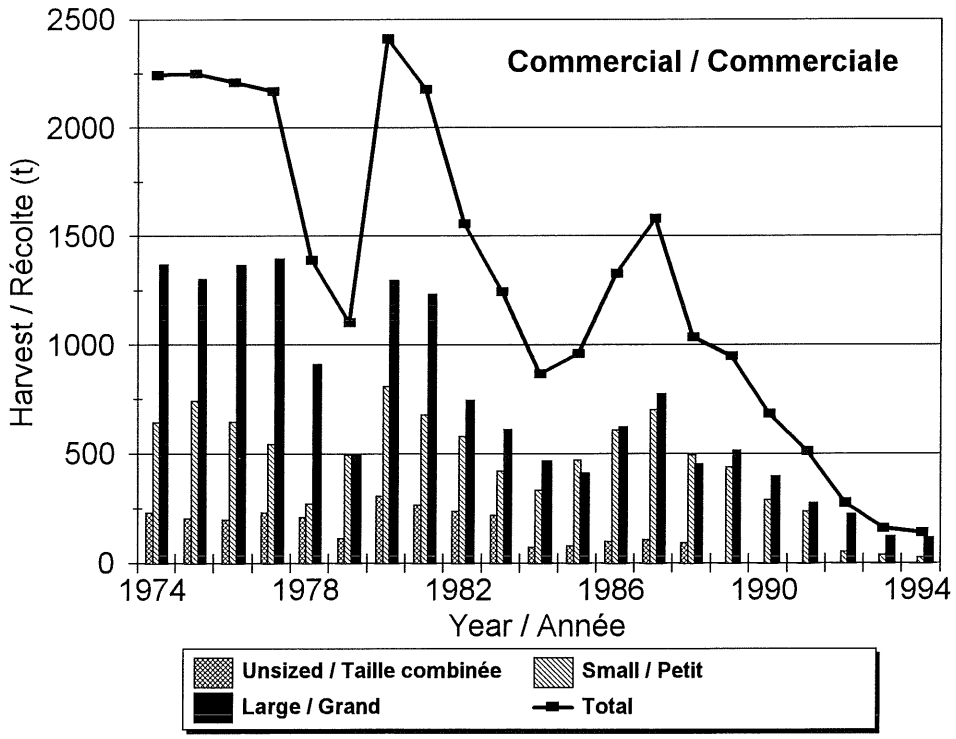
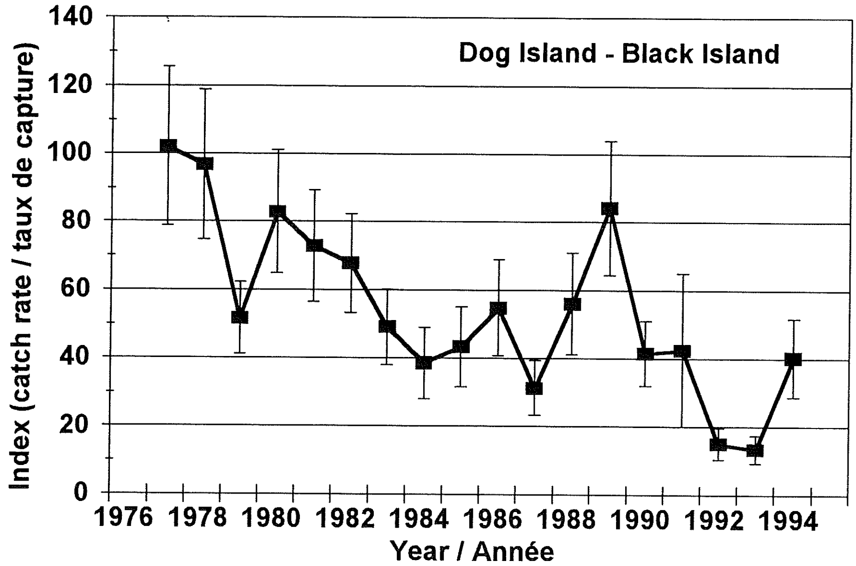


Figure 5.1.2.3. Trends in the Atlantic salmon commercial catch rate index from two combinations of subareas within the Nain Fishing Region of northern Labrador, 1977 to 1994. Vertical lines indicate the 90% confidence intervals.



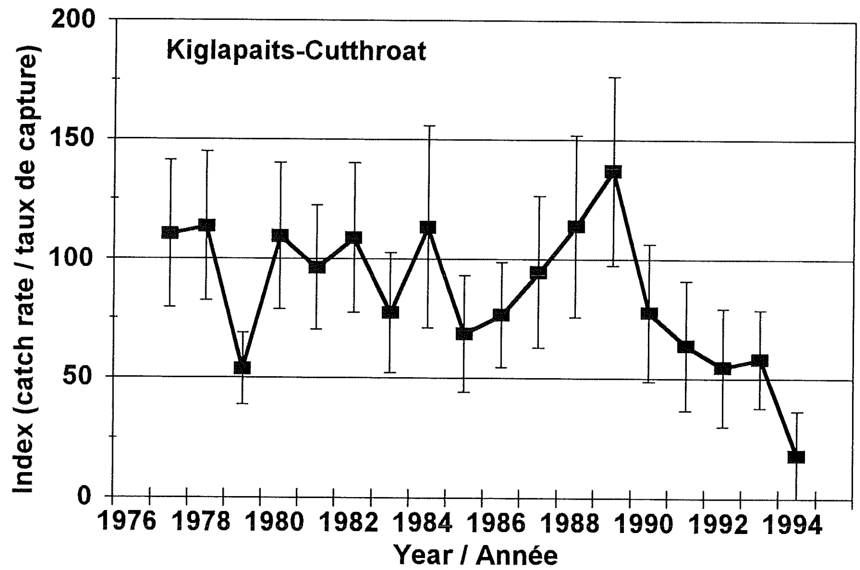
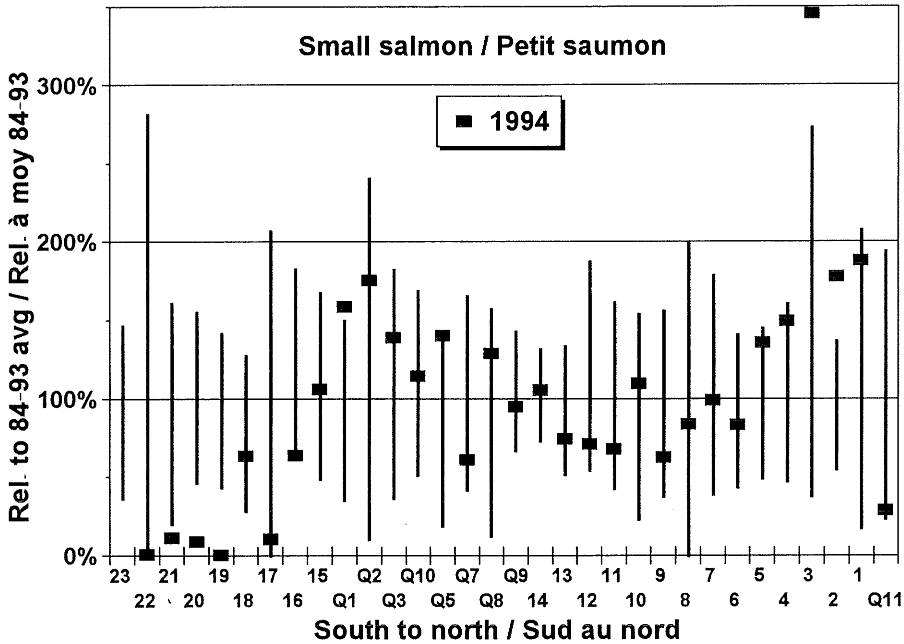


Figure 5.1.2.4. Recreational catches of small and large salmon scaled to the 1984 to 1993 average catch in each of the management areas of eastern Canada. The 1994 value is represented by the symbol, the vertical lines encompass the range for 1984 to 1993. A value of 100% means the catch was similar to the 1984 to 1993 average.



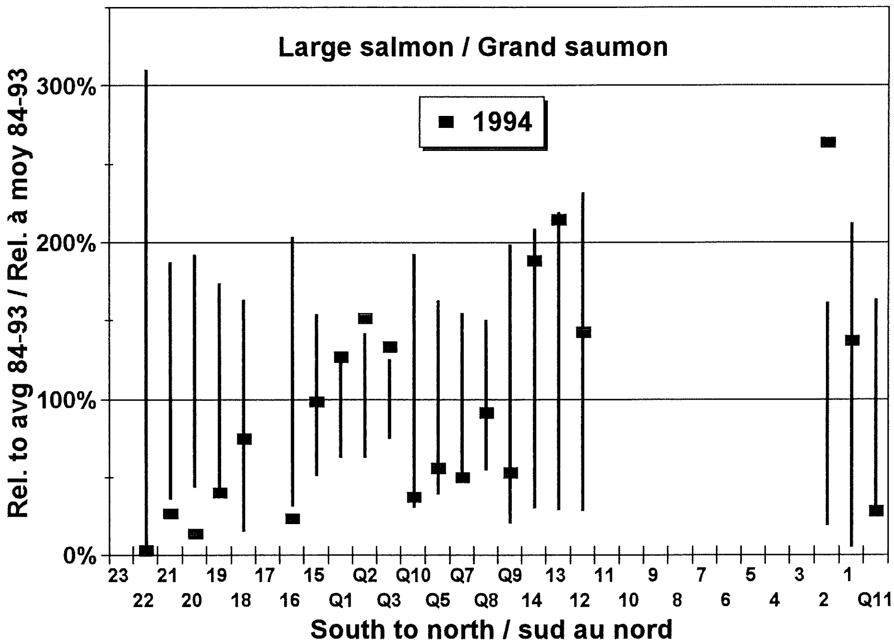


Figure 5.1.3.1 Composition, in terms of hatchery, wild and aquaculture escapees, of the returns of Atlantic salmon to rivers of eastern Canada in 1994

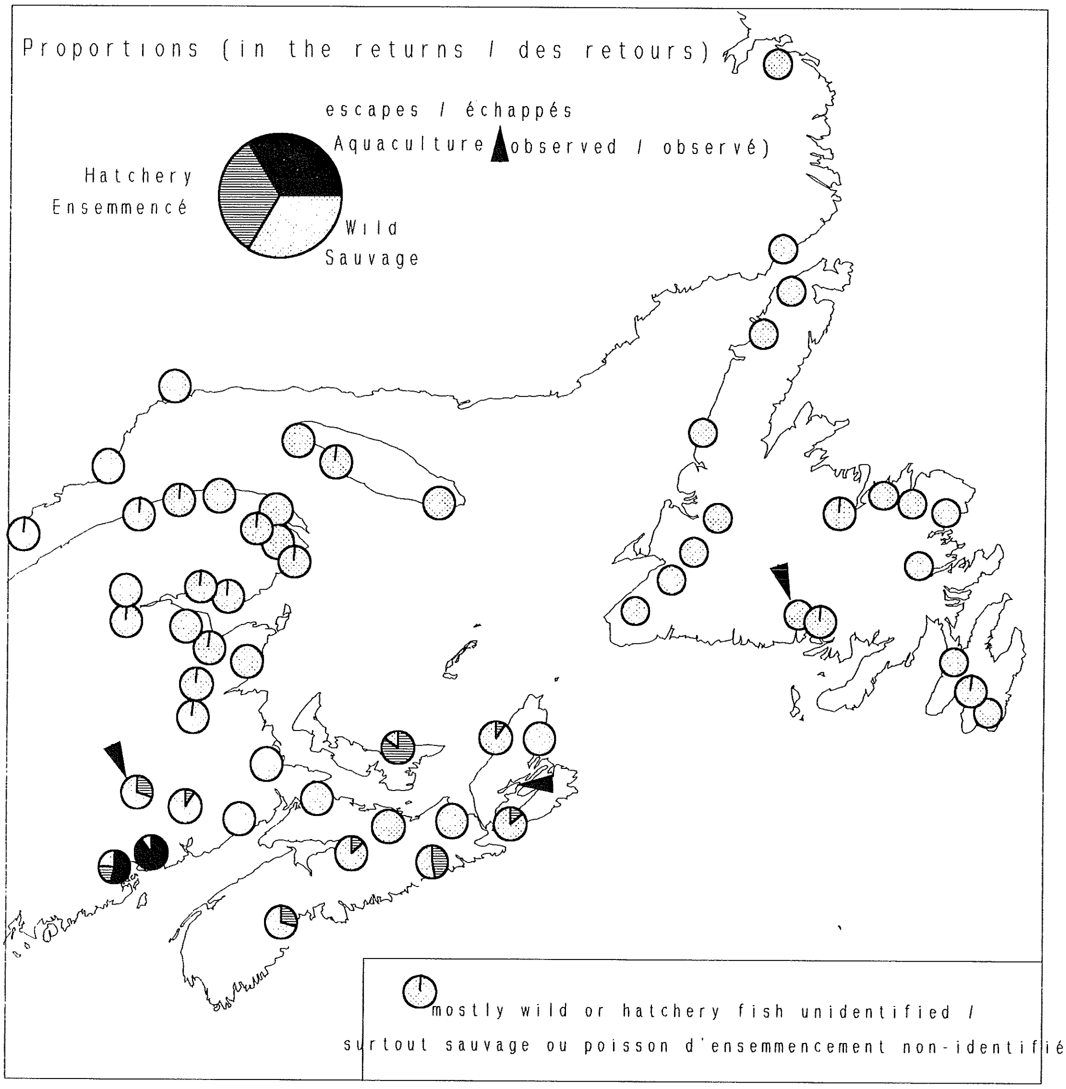
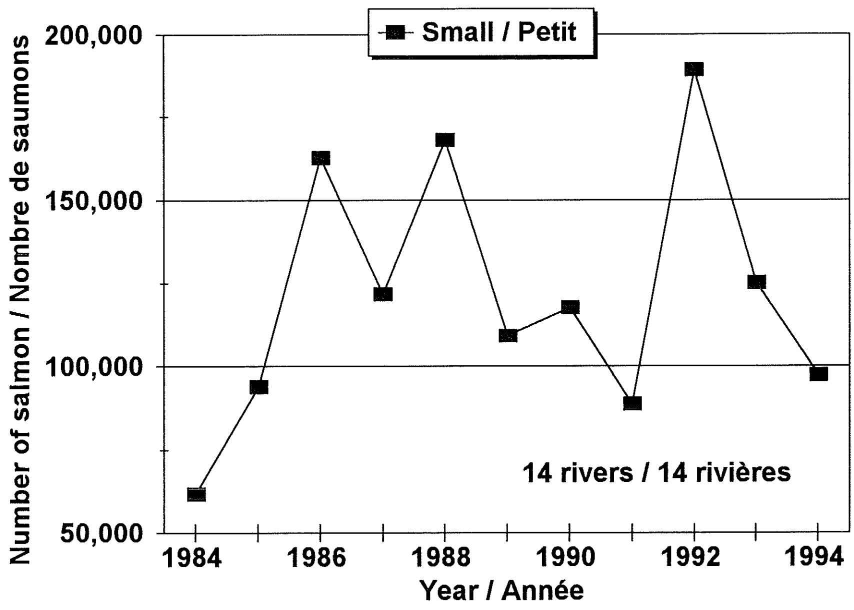


Figure 5.2.2.1 In-river returns of small and large salmon to 14 index rivers of eastern Canada, 1984 to 1993. These returns exclude harvests in the Newfoundland-Labrador and Greenland commercial fisheries.



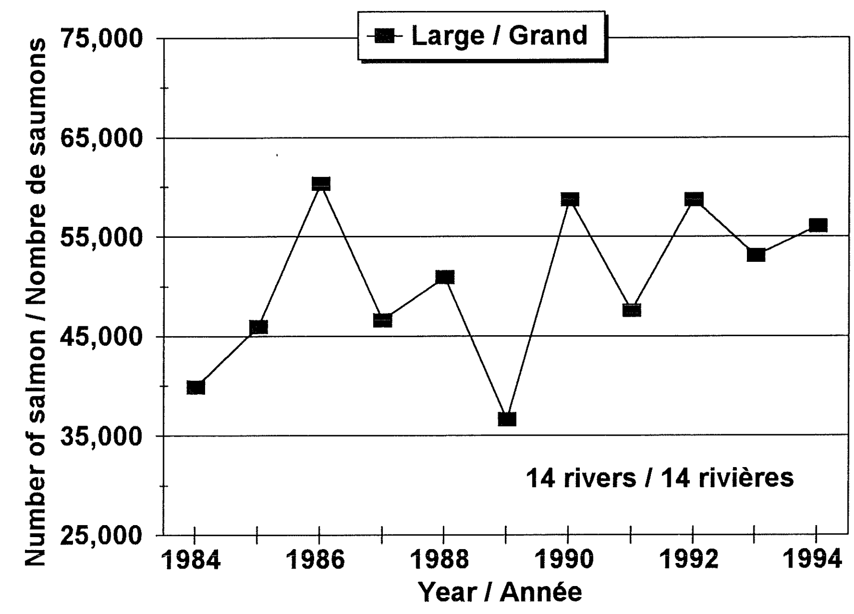


Figure 5.2.2.2 Numbers of Atlantic salmon (smolts, parr and fry) stocked in the USA, 1967-94.

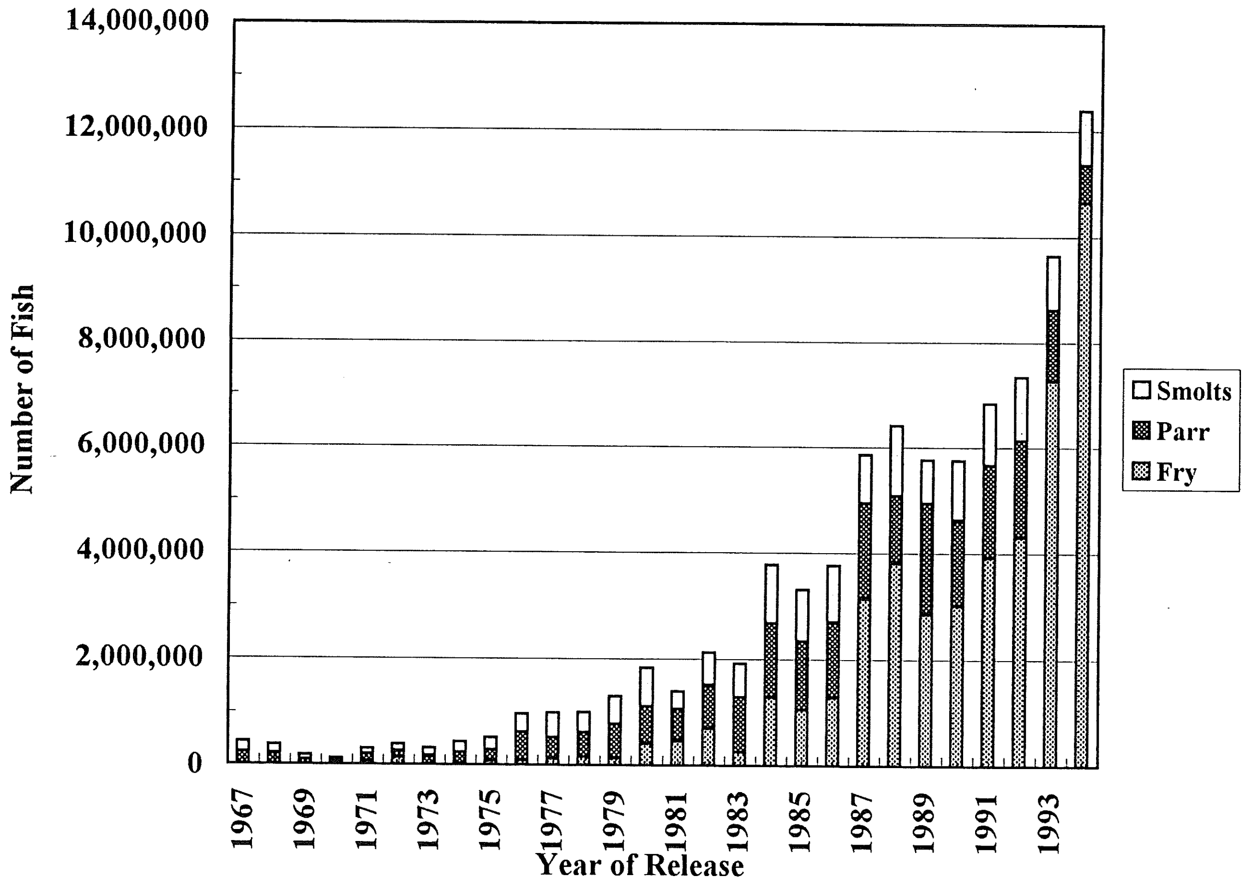


Figure 5.2.2.3 Documented returns of Atlantic salmon to USA rivers, 1967-94.

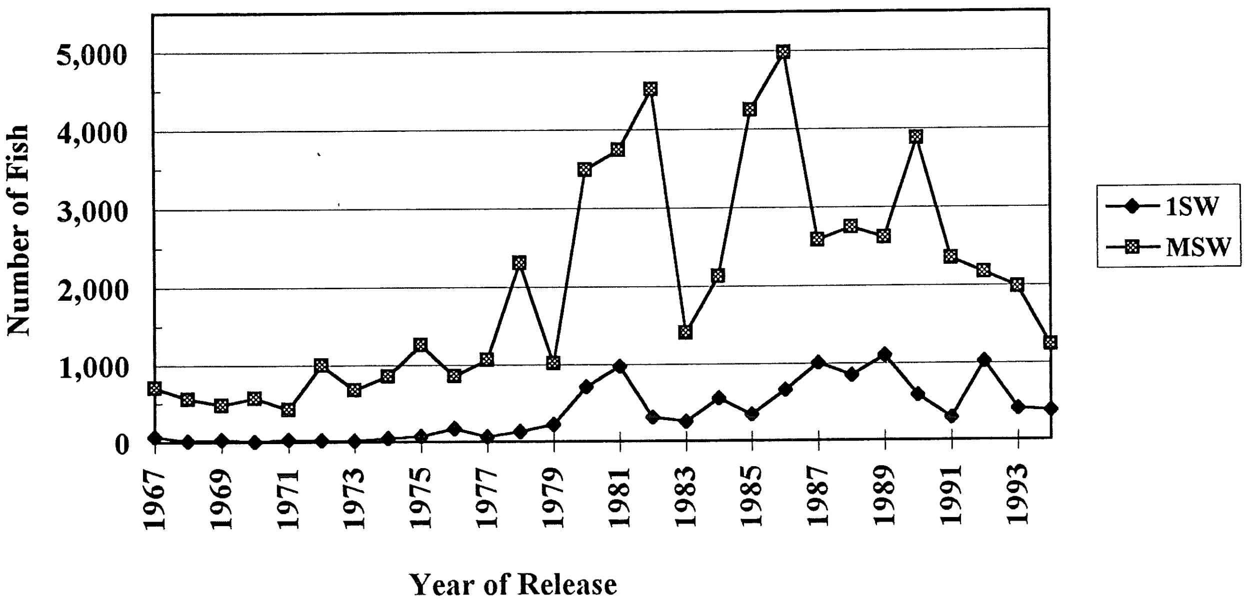


Figure 5.2.3.1. Egg depositions in 1994 relative to target in 63 rivers of eastern Canada.

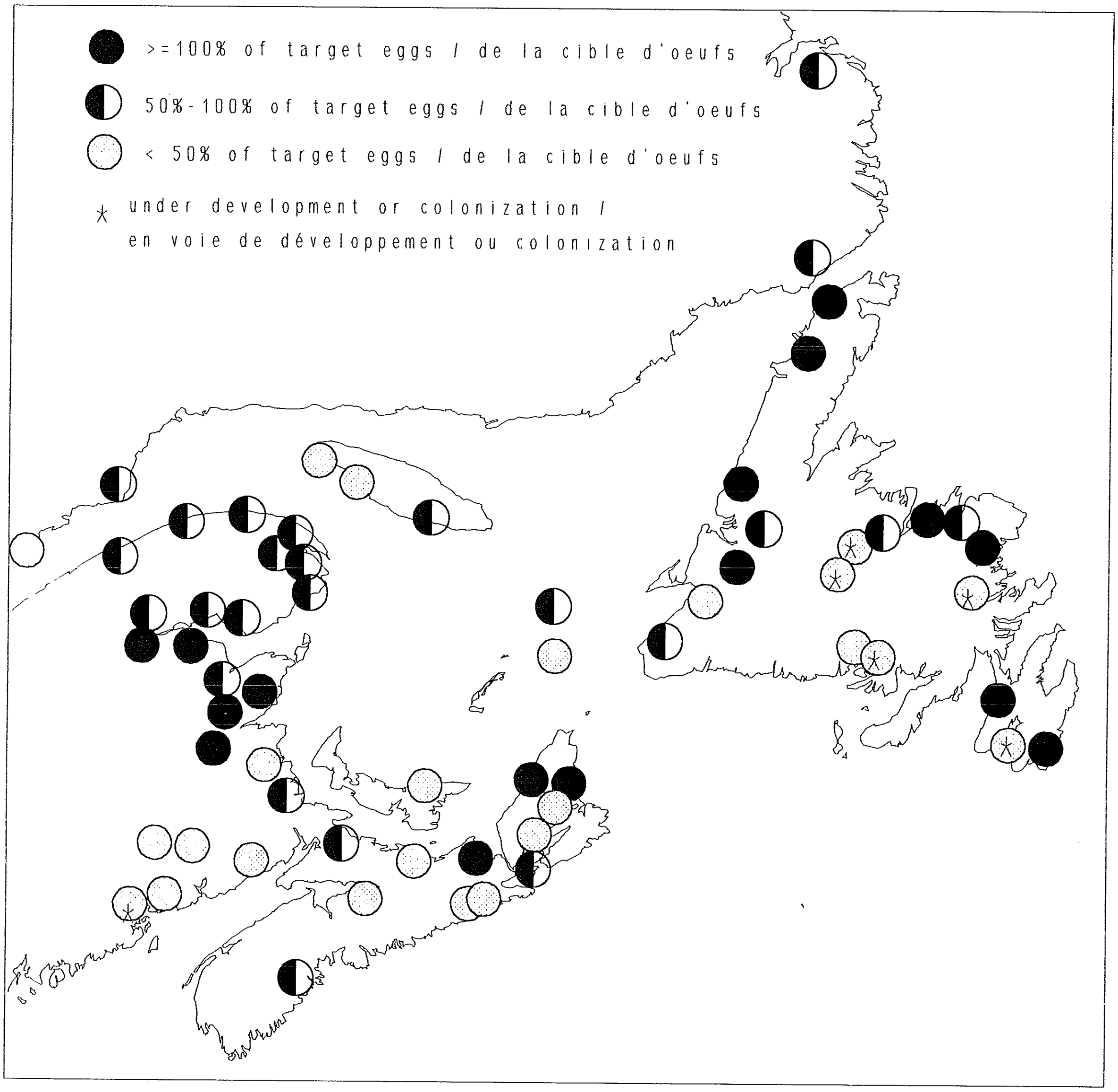


Figure 5.2.3.2 Comparison of estimated mid-points of 2SW returns (triangle) and 2SW spawners (circle) with 2SW spawning target (dashed line) in six geographic areas of North America for 1974-94 return years. (All lines are based on mid points of estimates)

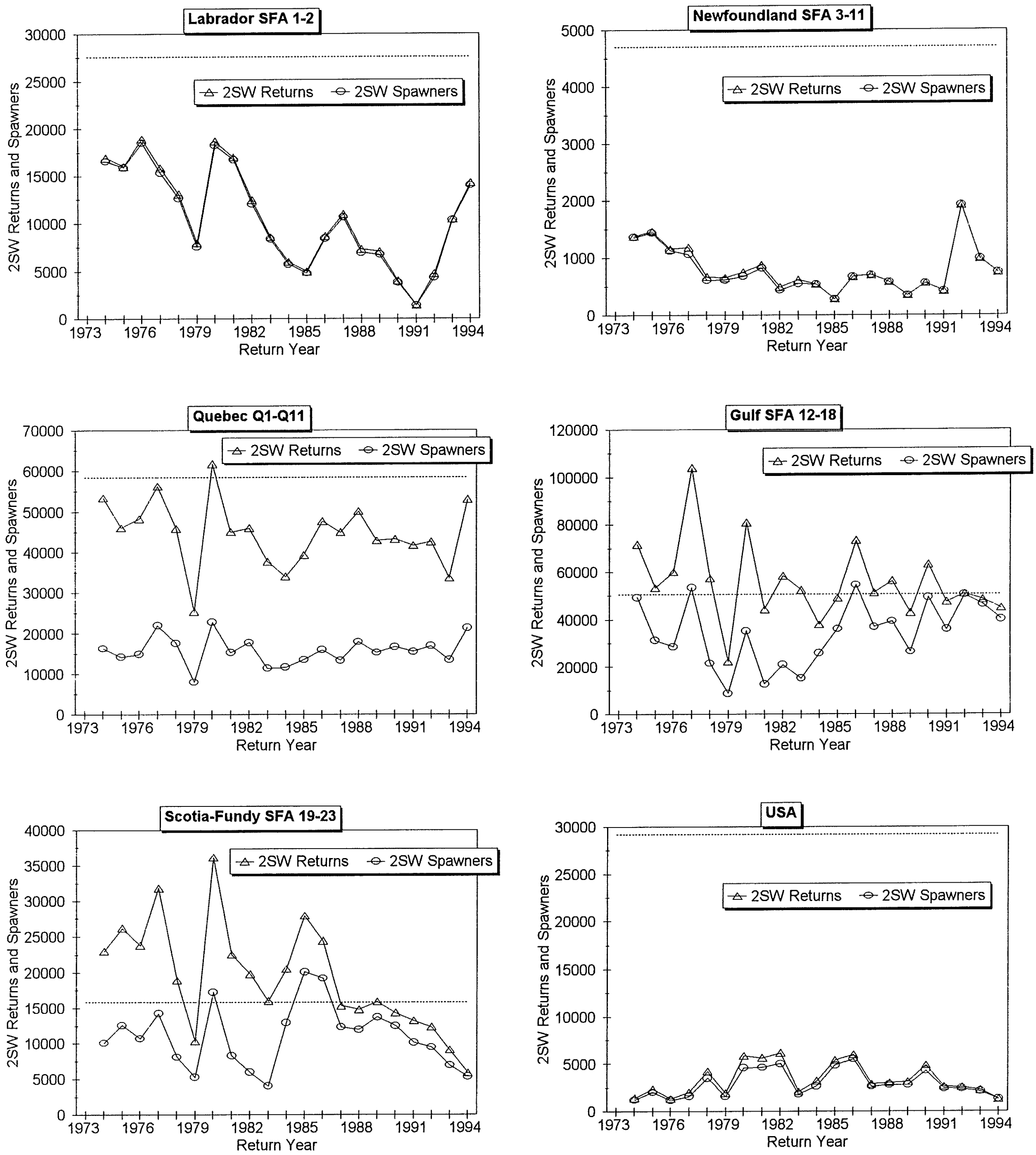


Figure 5.2.3.3 Comparison of estimated mid-points of 2SW returns (triangle) and 2SW spawners (circle) with 2SW spawning target (dashed line) in eastern Canada for 1974-94 return years. (All lines are based on mid points of estimates)

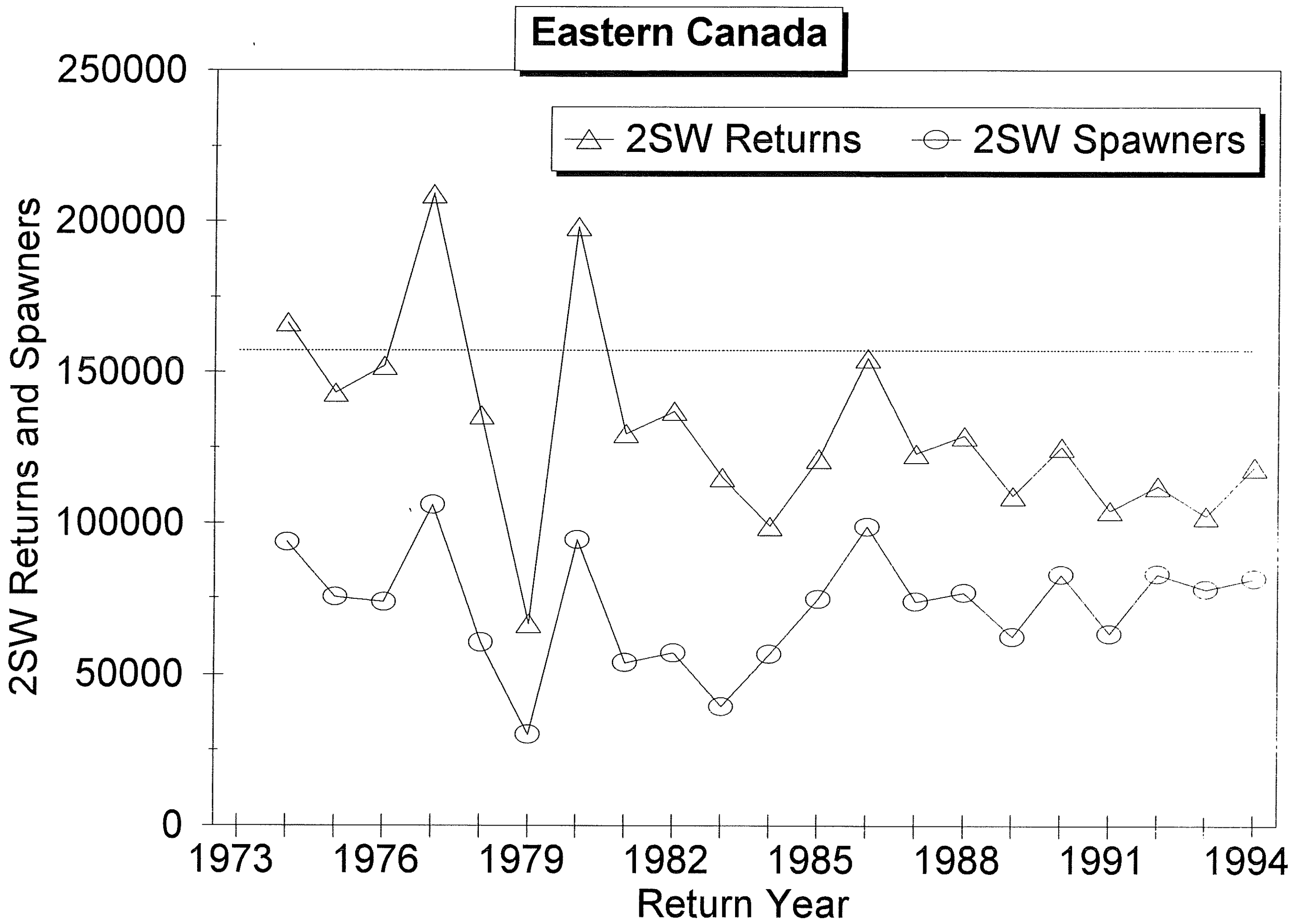


Figure 5.2.3.4 Comparison of potential 2SW returns without fisheries (solid square), actual 2SW returns (triangle) and 2SW spawners (circle) with 2SW spawning target (dashed line) for North America for 1974-94 return years. (All lines are based on mid points of estimates)

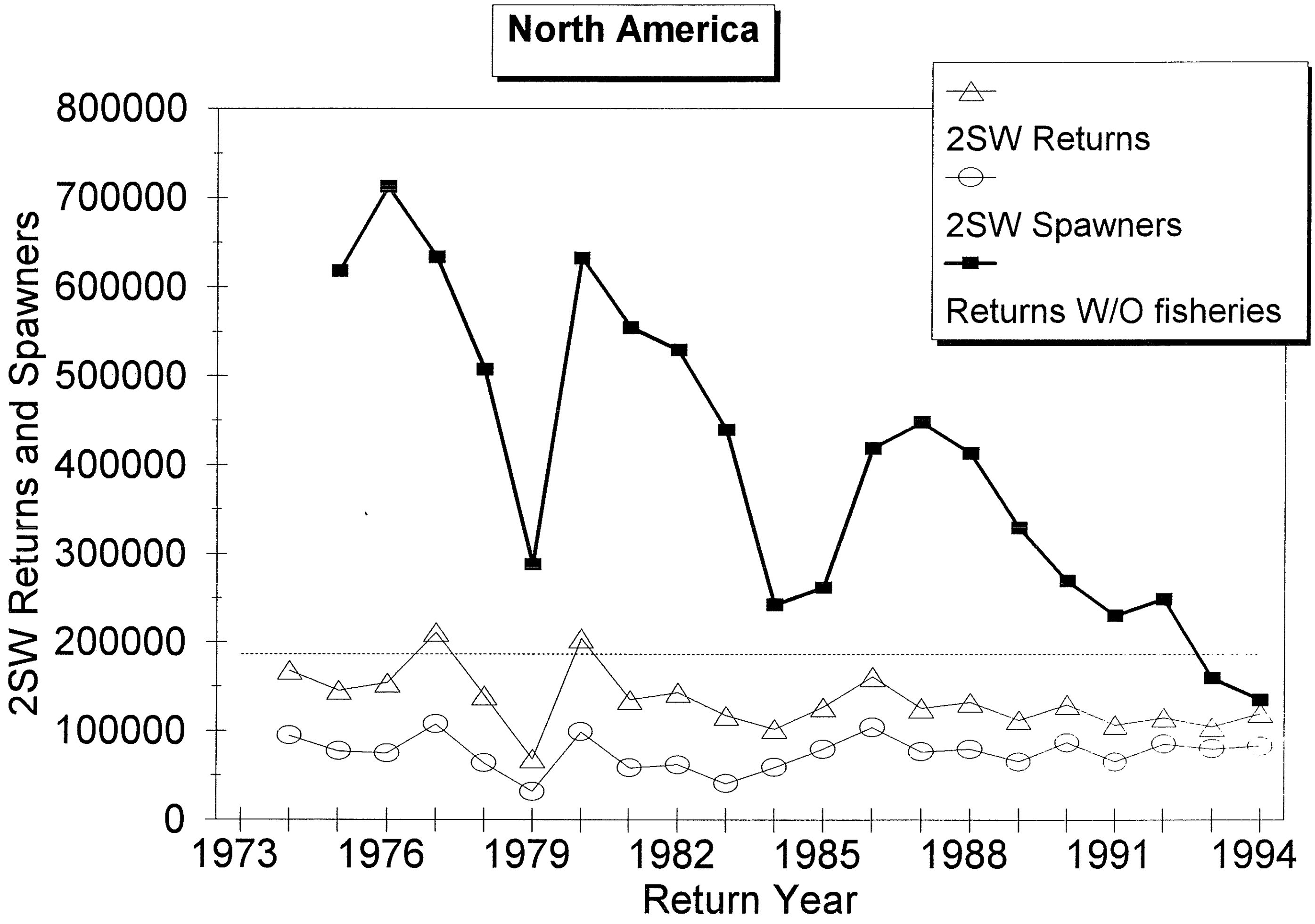
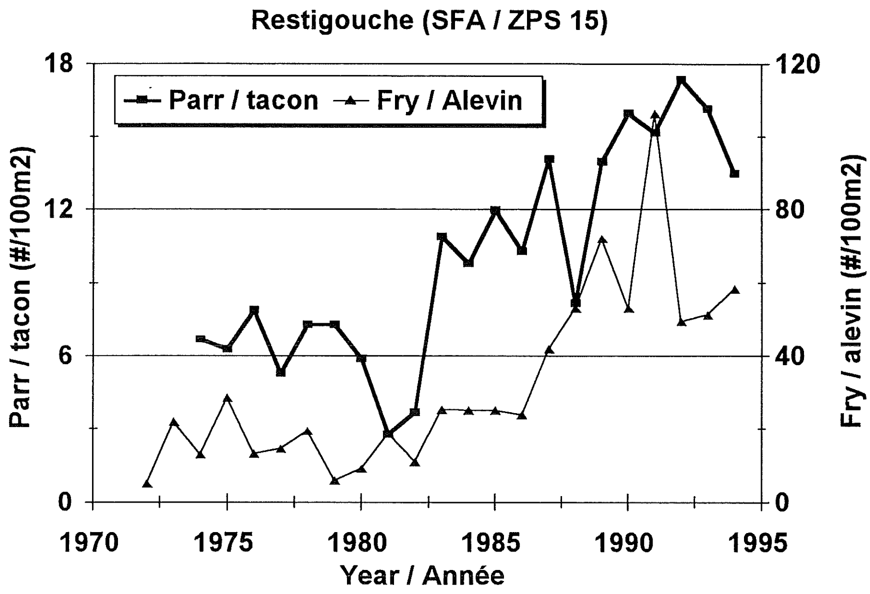


Figure 5.2.3.5 Juvenile Atlantic salmon abundance indices in the Restigouche River (SFA 15) and Mirimichi River (SFA 16) based on sampling at 15 standard sites in each river during 1971-94.



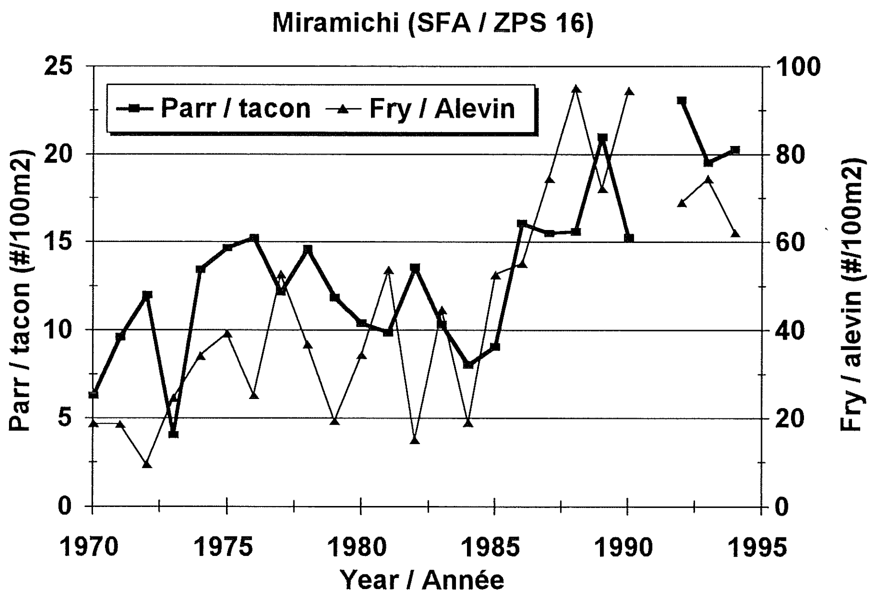
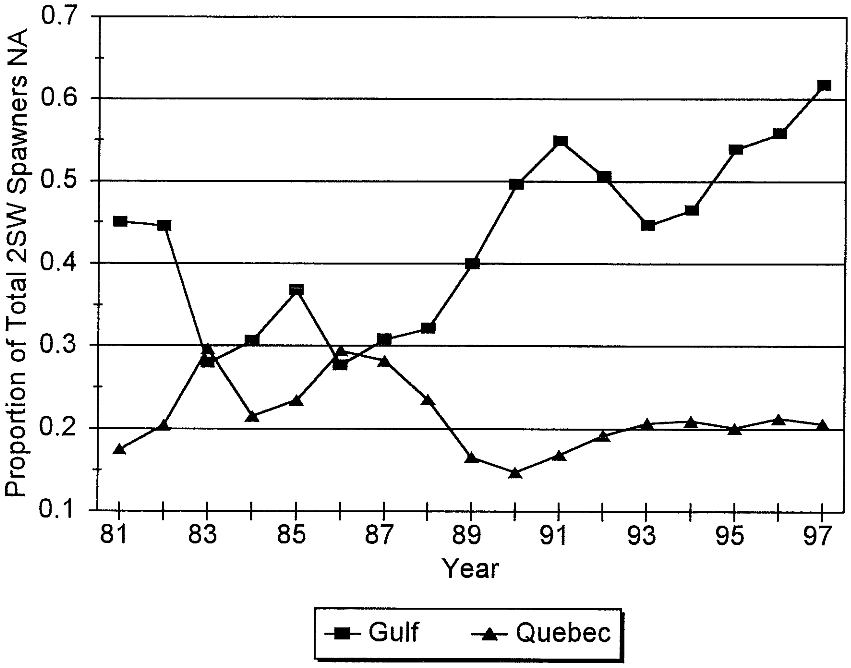


Fig. 5.2.3.6. Contributions to the total North American 2SW lagged spawning stock for the four main geographical areas of North America. Year refers to the year of prefishery abundance to which the lagged spawners would be expected to contribute recruitment.



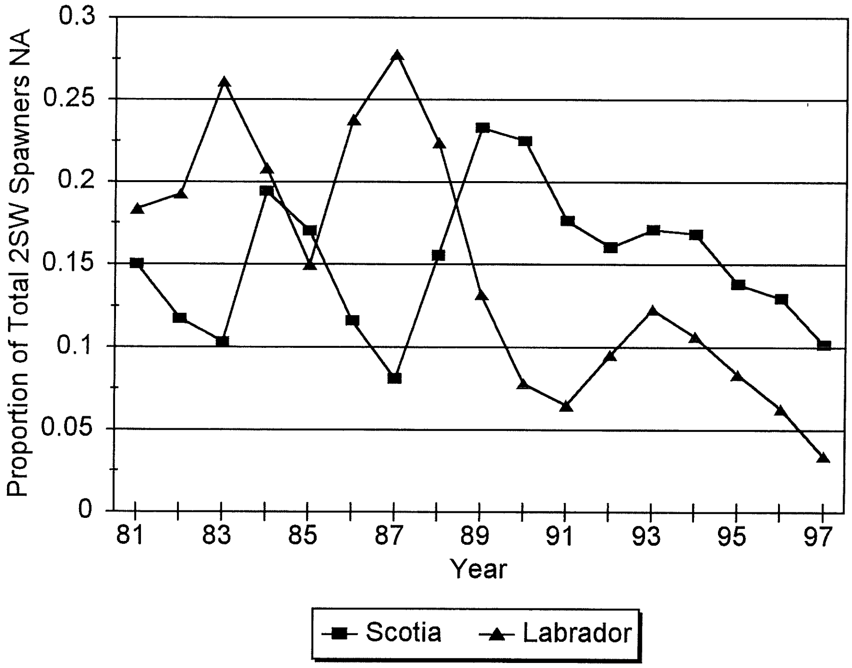
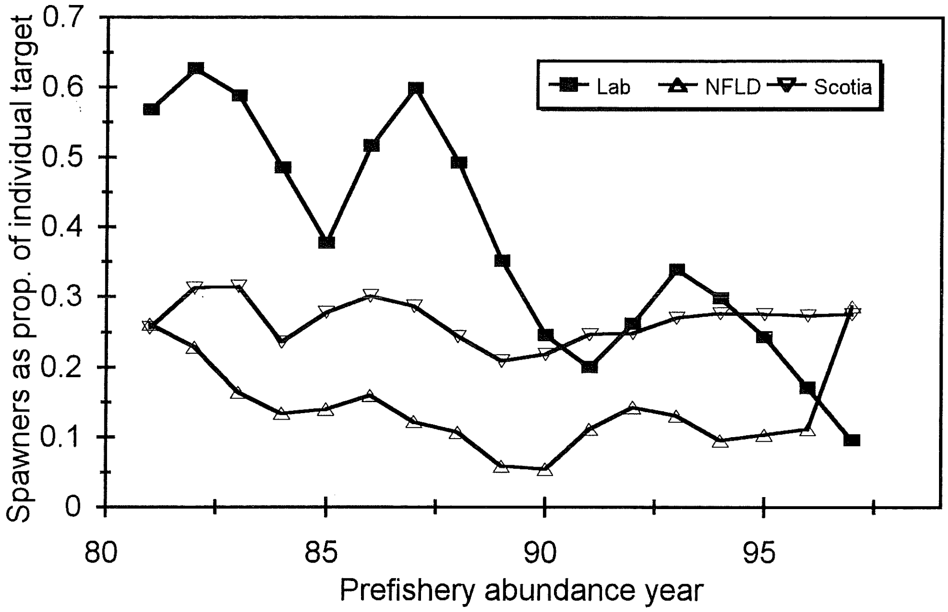


Fig. 5.2.3.7. Contributions of lagged spawners expressed as the proportion of the individual area spawner targets in the six geographic areas of North America for the prefishery abundance years 1981 to 1997



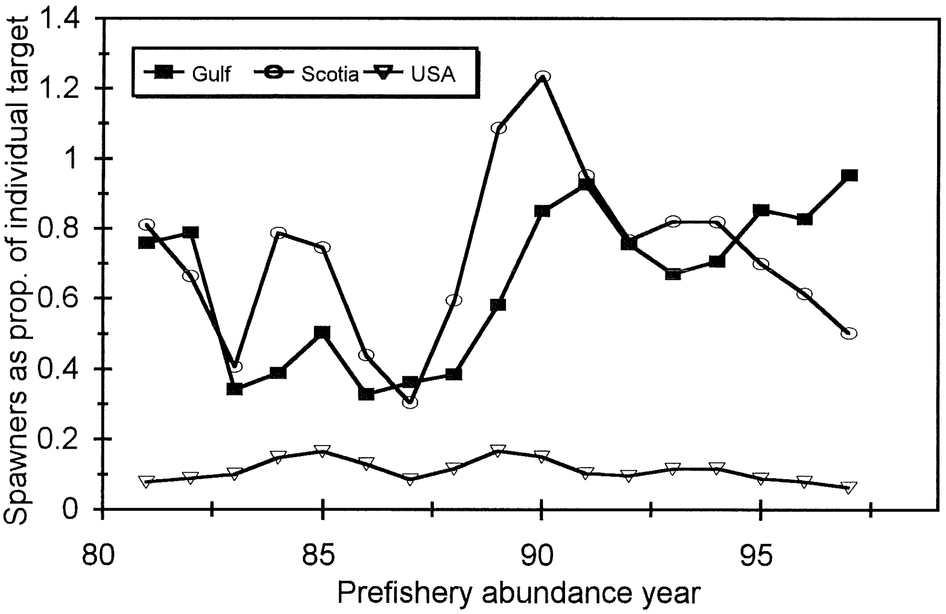


Figure 5.2.4.1. Trends in survival rates of hatchery and wild smolts to small salmon (or 1SW returns for the Saint John River) in river of eastern Canada. Year refers to the year of smolt migration.

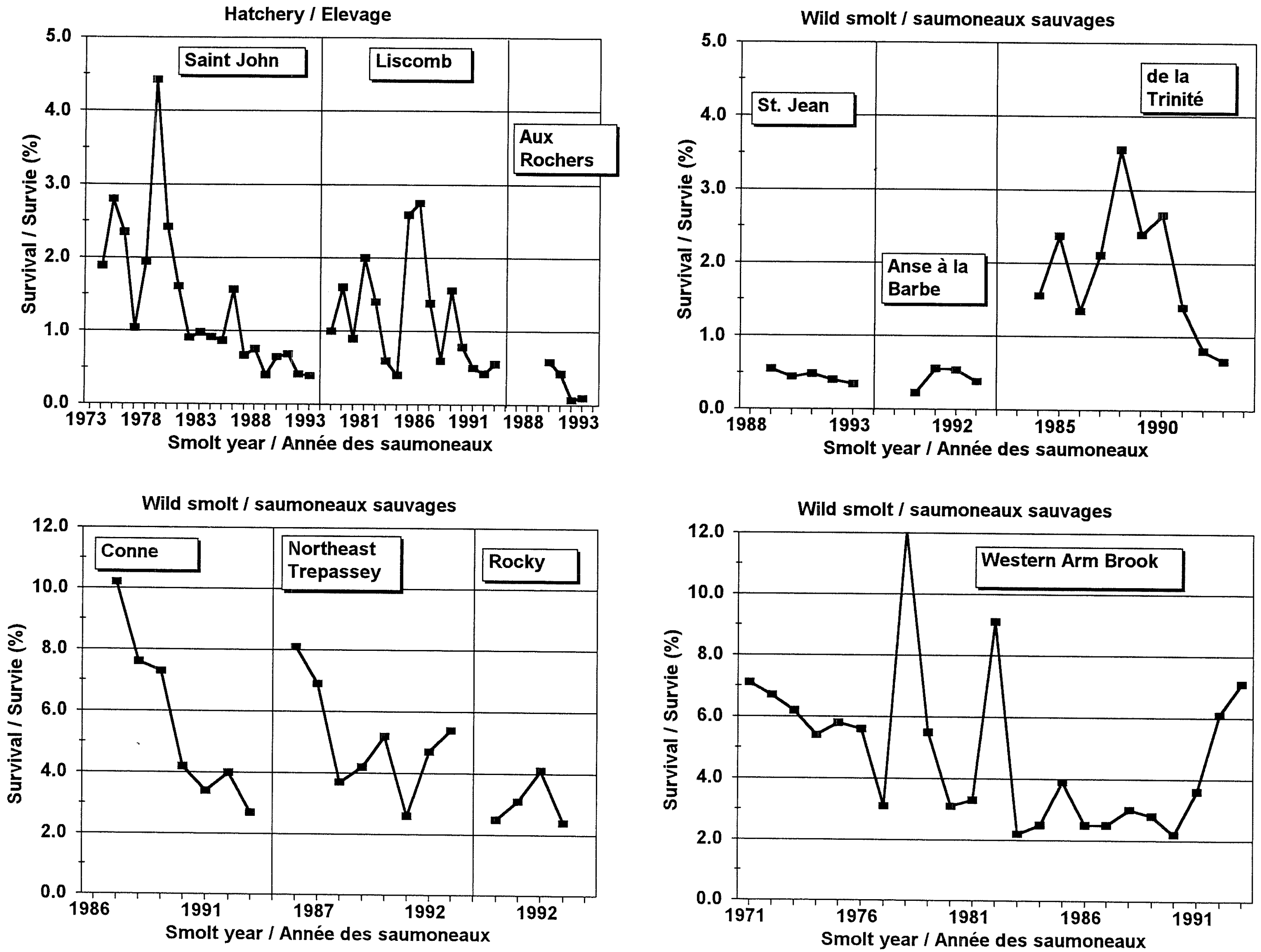


Figure 5.2.4.2. Smolt to small salmon survival indices relative to the April 1 to May 15 air temperature index at Conne River, Newfoundland (SFA 11), 1987 to 1993. Year label is the year of smolt migration.

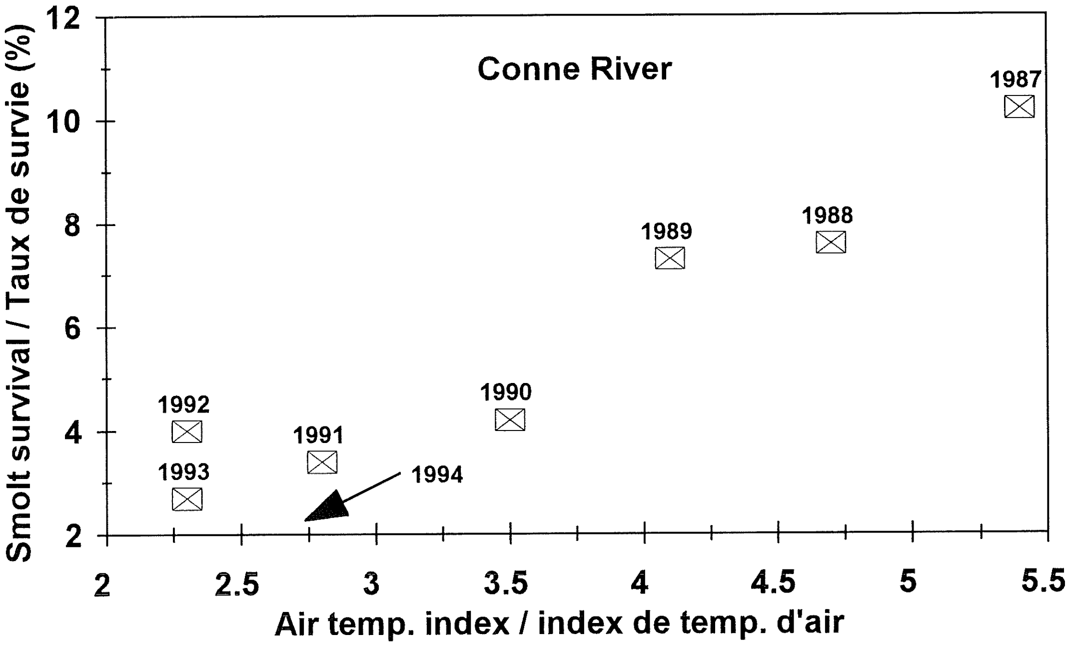


Figure 5.2.4.3 Marine survival of hatchery Atlantic salmon smolts released into the Penobscot River in 1969-93.

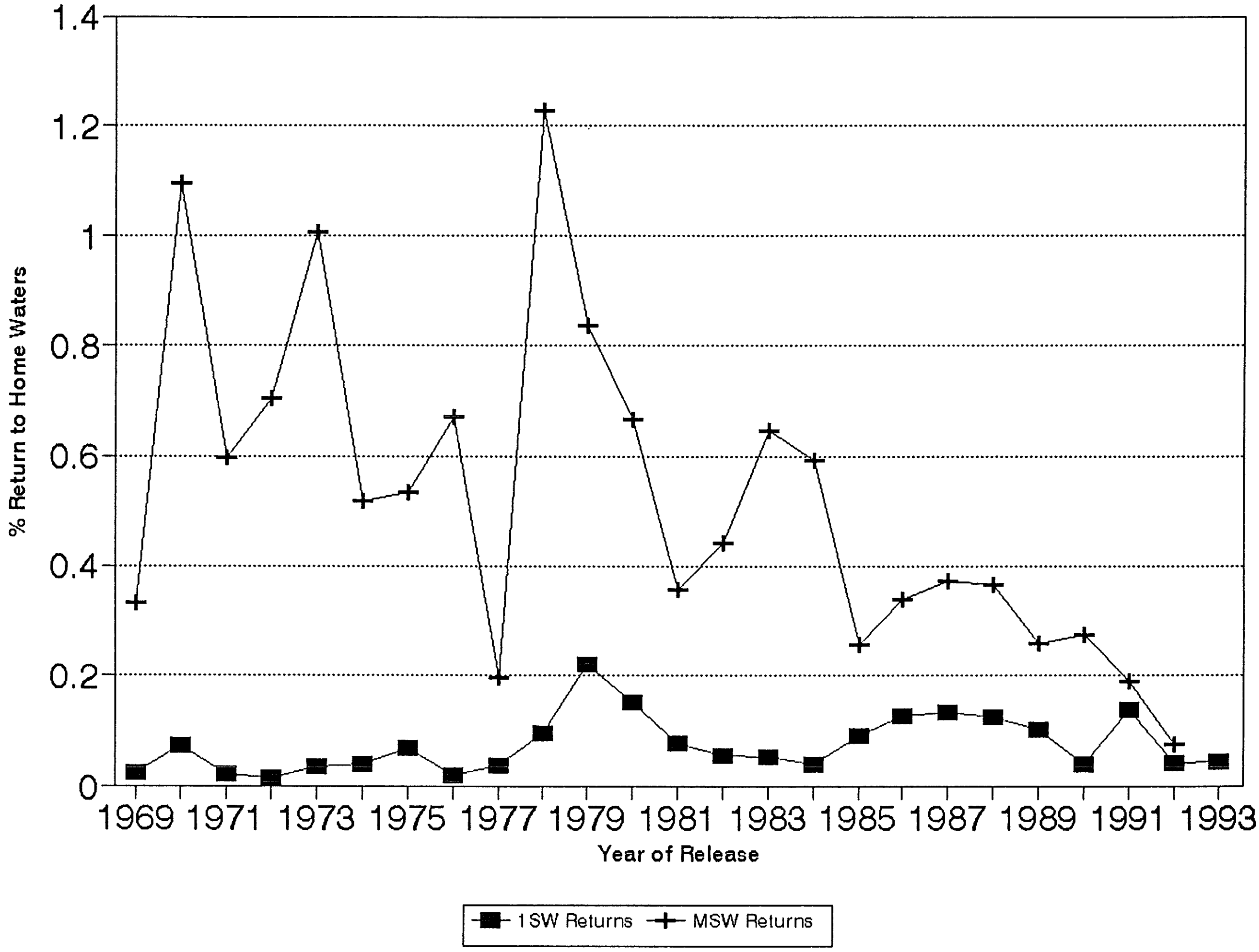


Figure 6.1.3.1. Extant exploitation of North American 2SW salmon stocks in Newfoundland-Labrador and Greenland commercial fisheries.

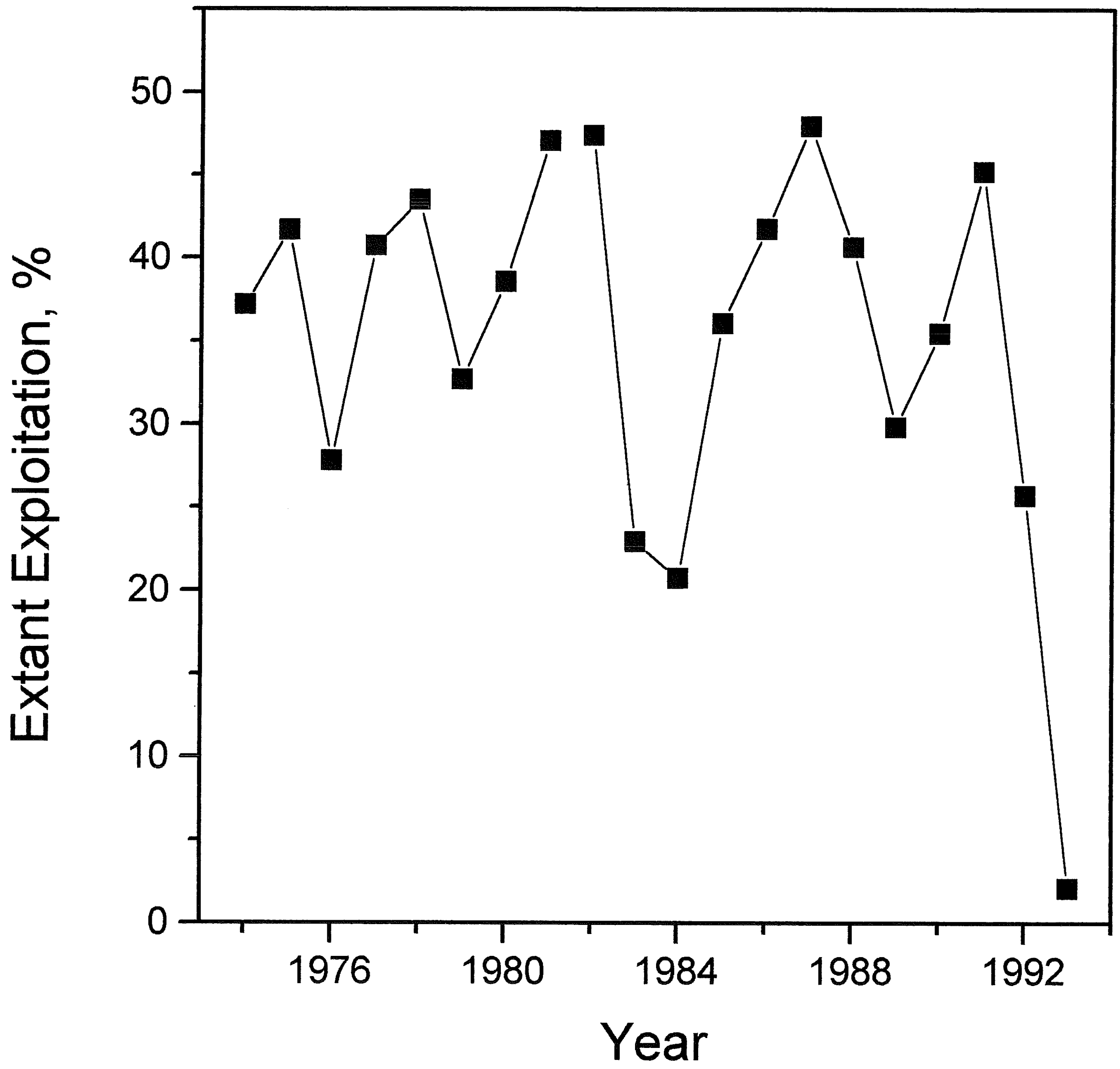


Figure 7.1.1 Comparison of smolt to 1SW survival rates from Western Arm Brook, Newfoundland in pre- and post-moratorium years

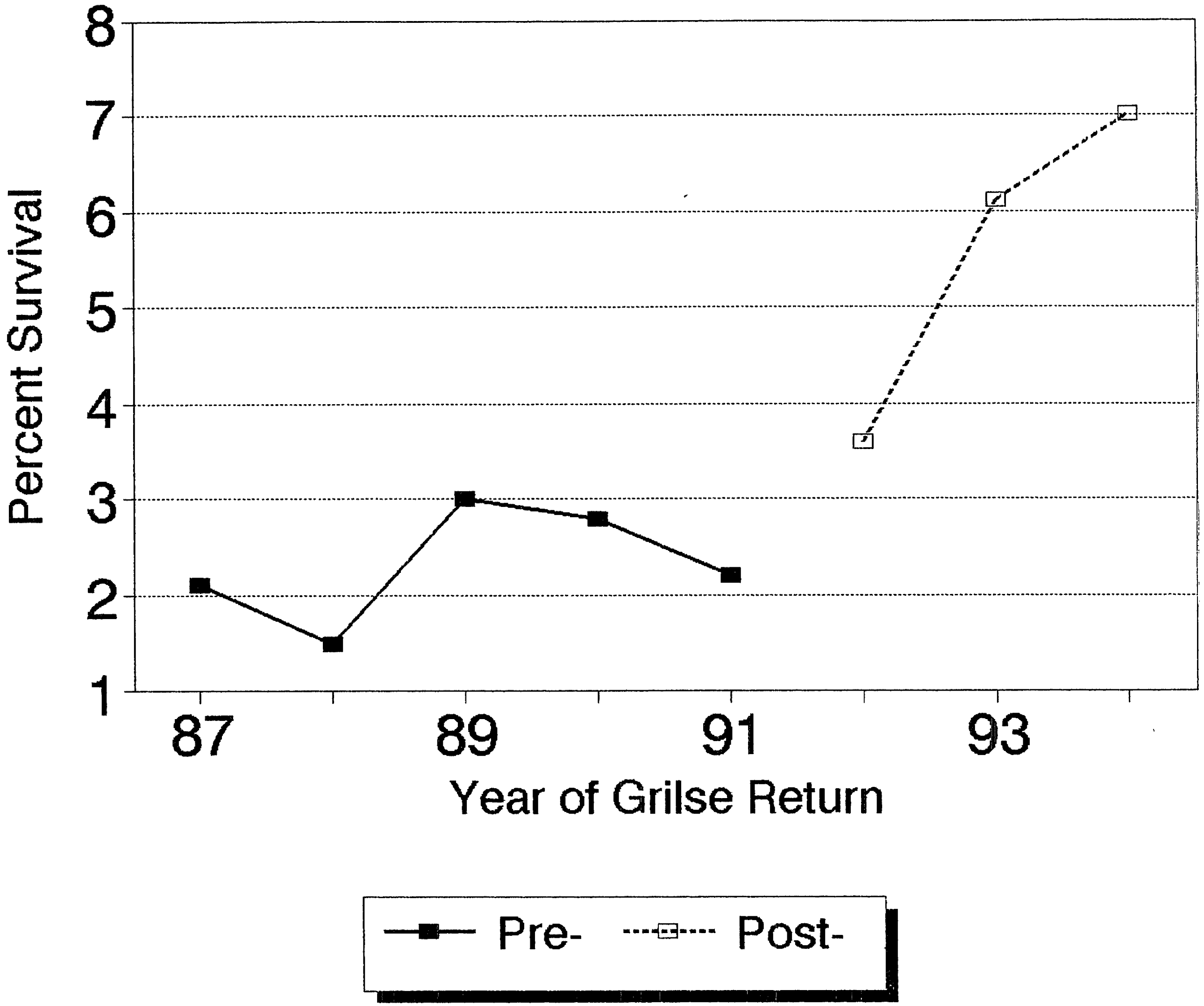


Figure 7.1.2 Comparison of smolt to second spawning for Mirimichi River, New Brunswick, salmon.

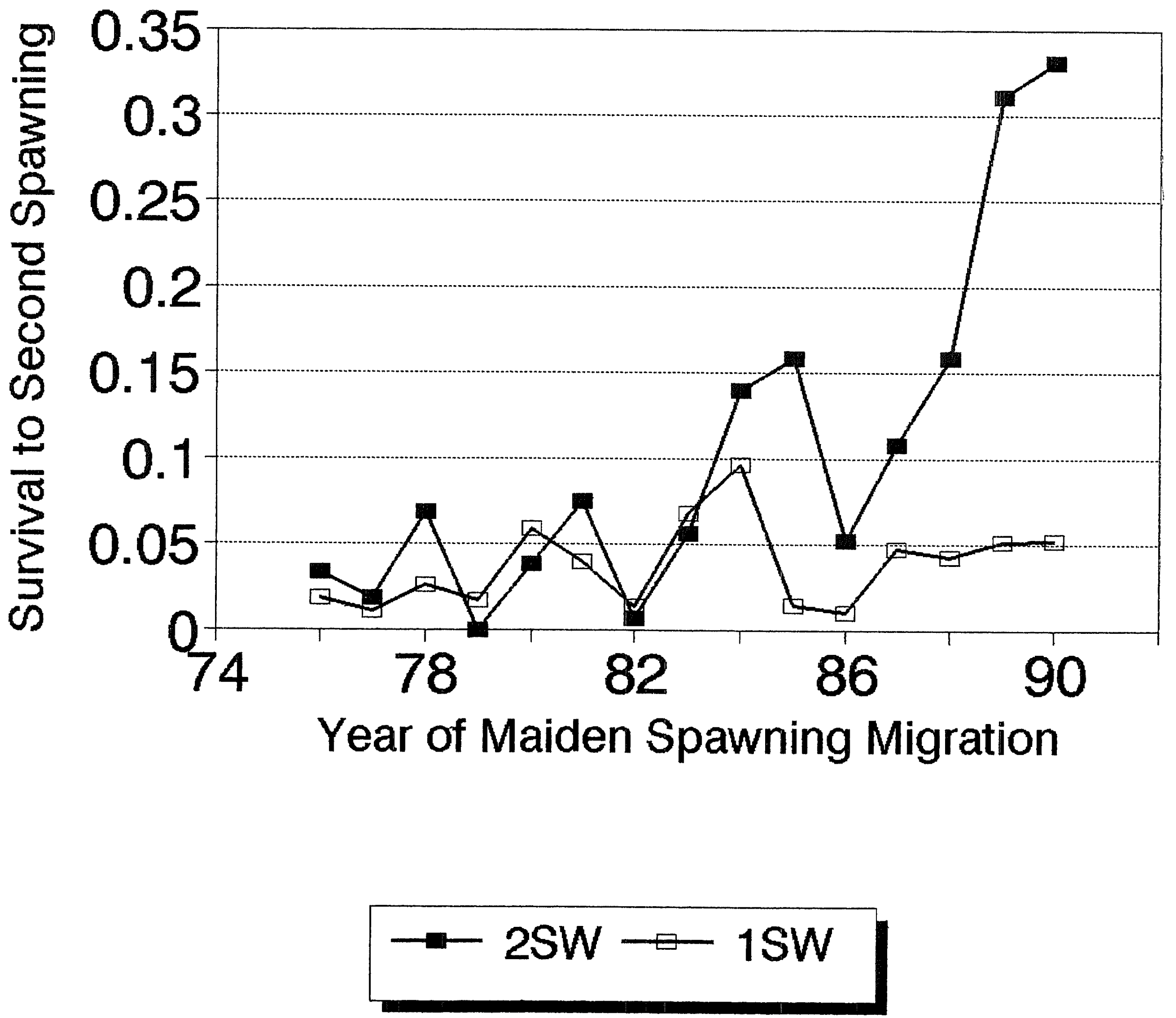
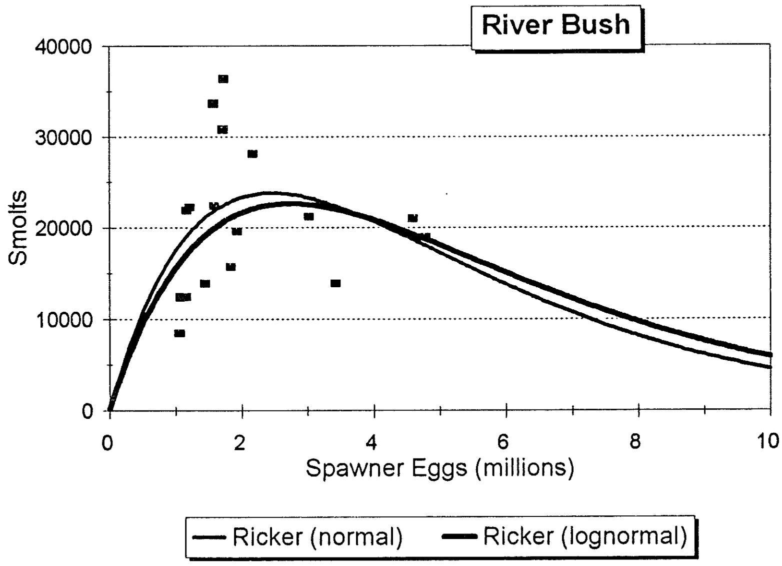
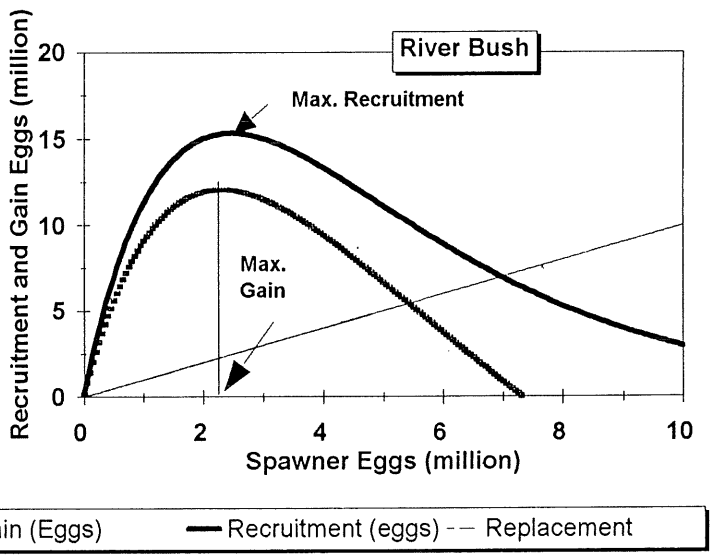


Figure 8.1.1.1 Analysis of stock-recruitment data for River Bush (UK(N.Ireland))





Ricker model: Recruitment = alpha*Spawners*exp(-beta*Spawners)

Results assuming lognormal error structure

alpha	0.024	
beta	0.364	* E-06

Reference Points	Eggs (million)
Max. Gain (millions)	2.310
90% Max. Gain (millions)	3.385
Max. Recruitment	2.760
Replacement (millions)	7.335

Figure 8.2.3.1 Maximum and minimum estimates of recruitment of maturing (solid lines) and non-maturing (dotted lines) 1SW salmon in the North-East Atlantic Commission area

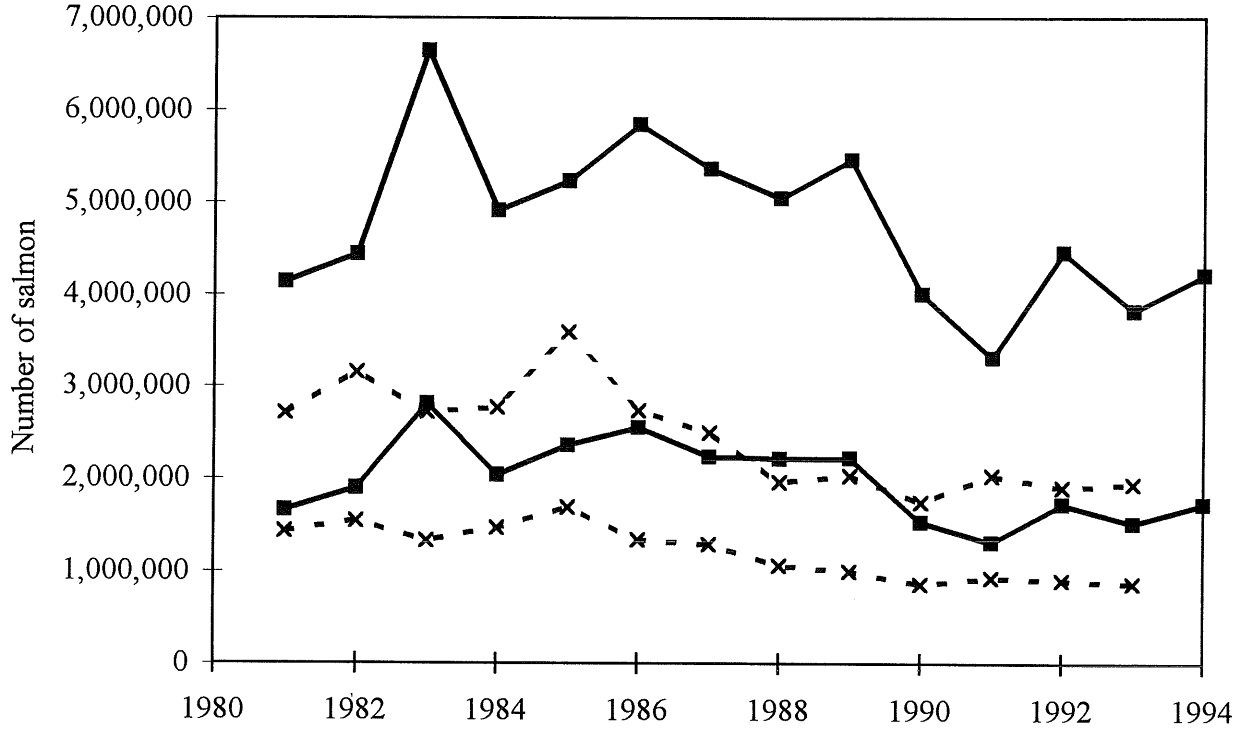


Figure 8.2.3.2 Maximum and minimum estimates of recruitment of maturing (solid lines) and non-maturing (dotted lines) 1SW salmon in Southern European stock complex.

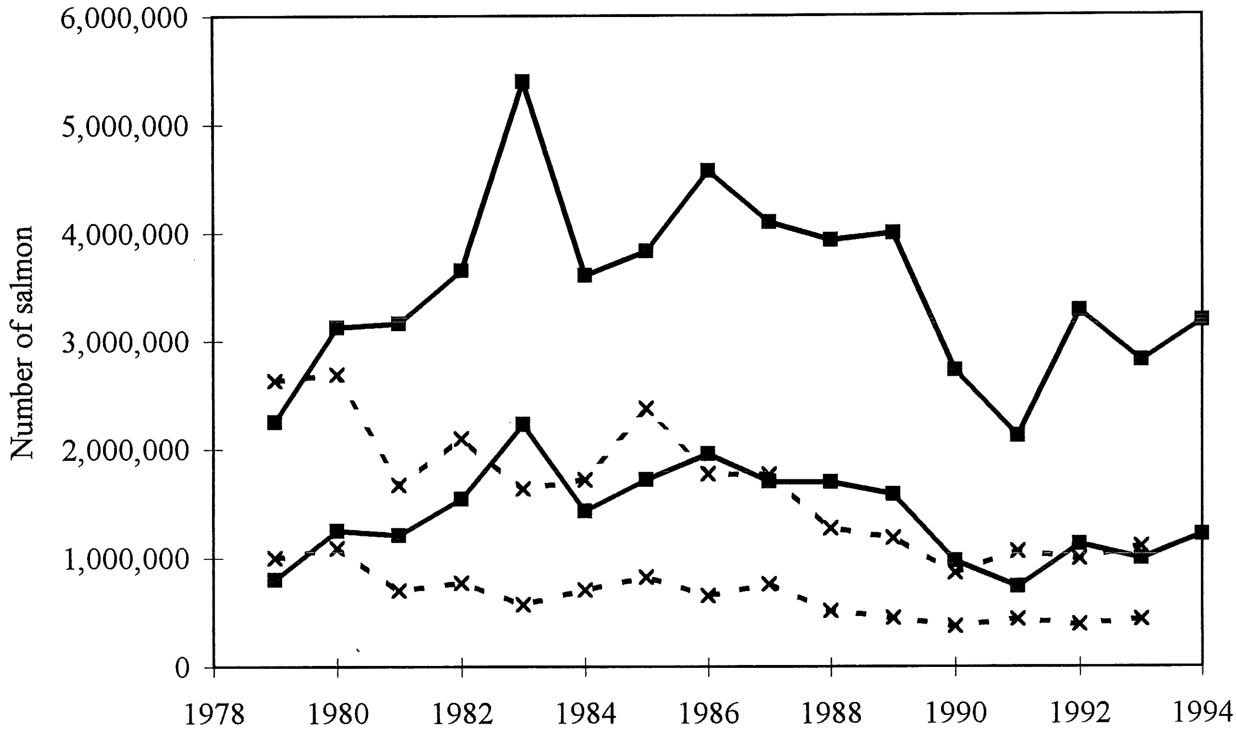


Figure 8.2.3.3 Maximum and minimum estimates of rtecruitment of maturing (solid lines) and non-maturing (dotted lines) 1SW salmon in Northern European stock complex.

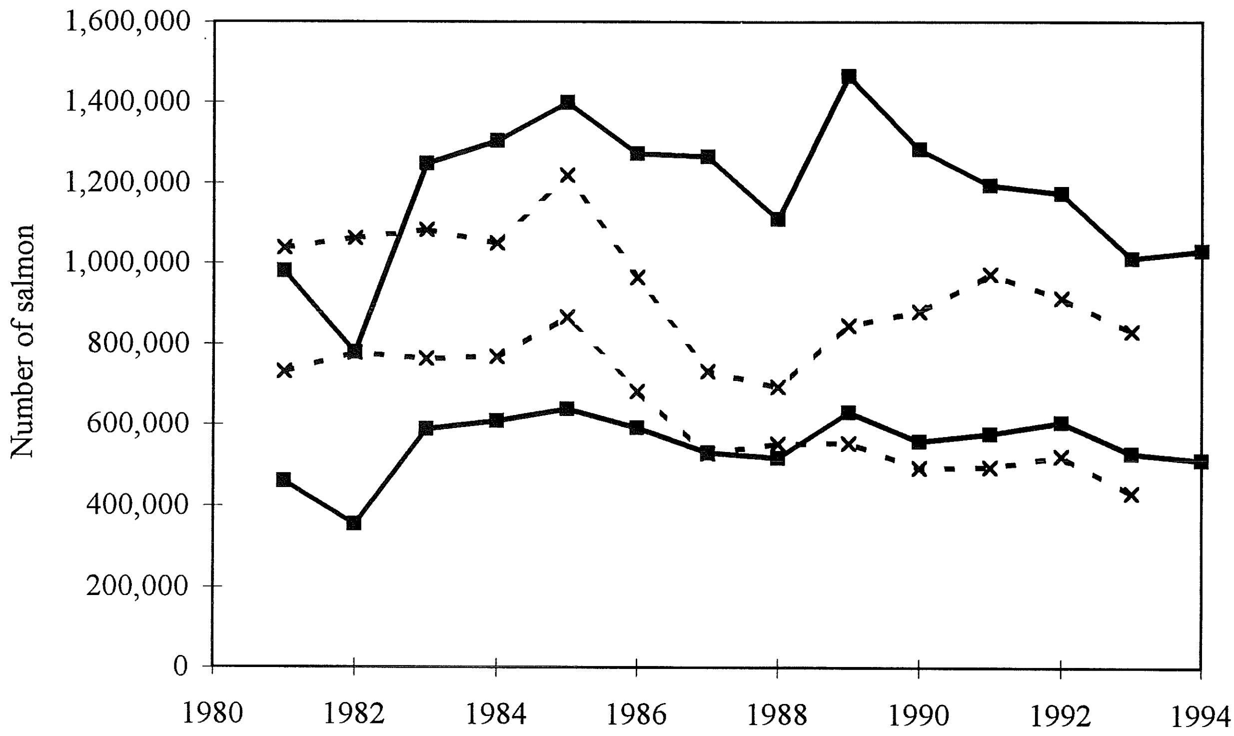


Figure 8.2.4.1 Location of index stocks (Figgio and North Esk) and general location of post-smolt habitat area

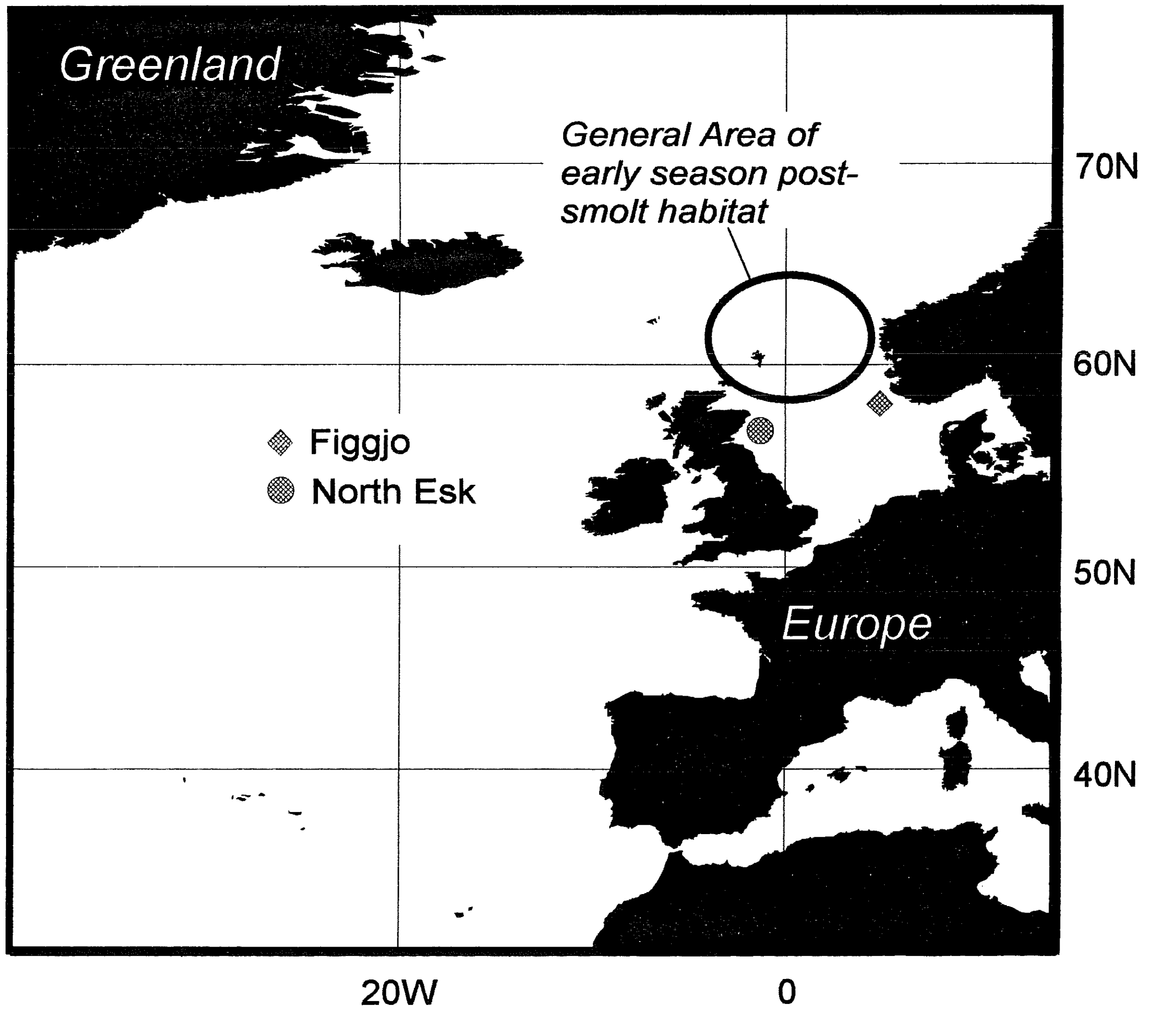


Figure 8.2.4.2 Time series of 1SW survival rate and area of sea surface temperature for May and November

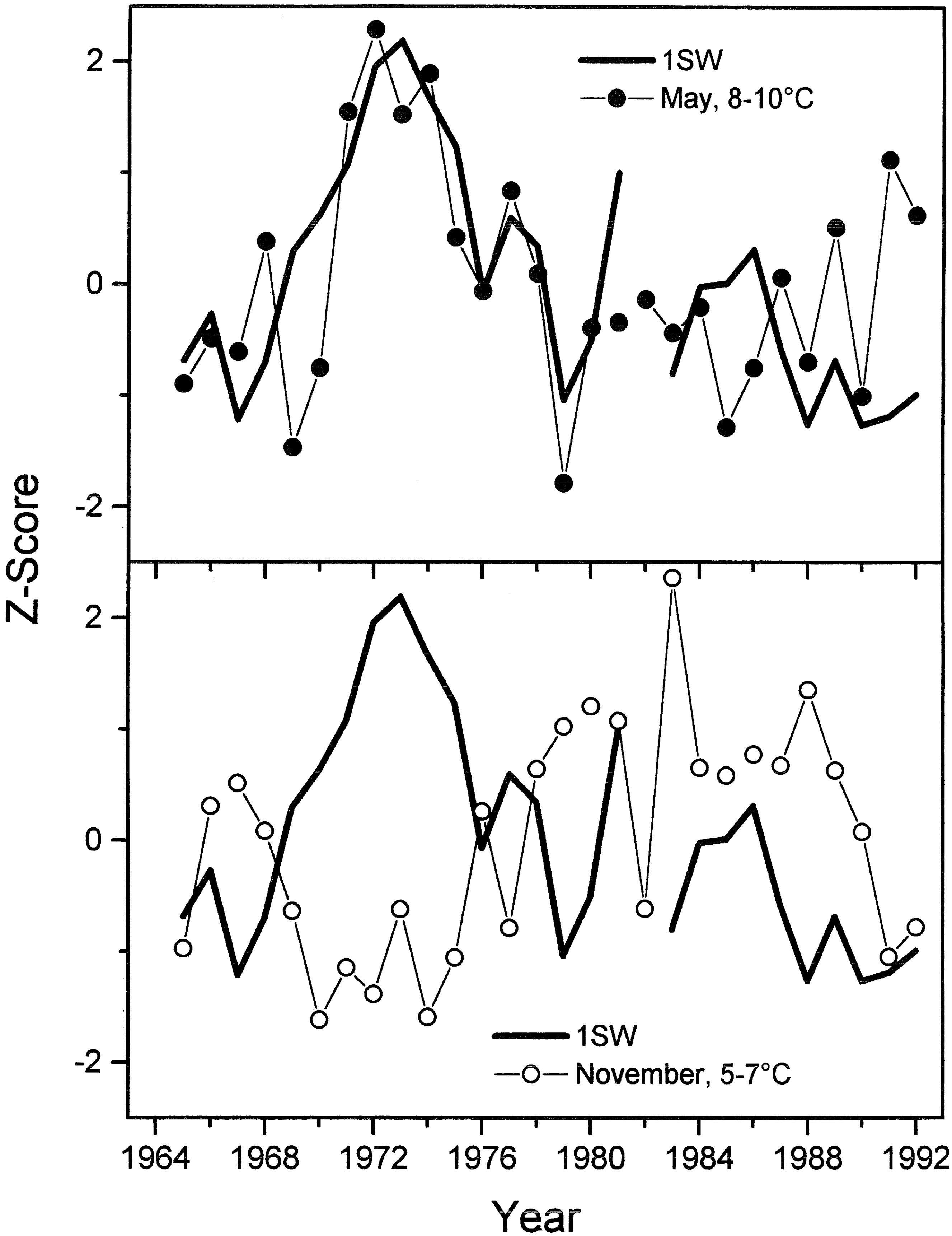


Figure 8.2.4.3 Relationship between mean weight of returning 1SW salmon and percentage of fish returning as MSW salmon to River Lagan, Sweden.

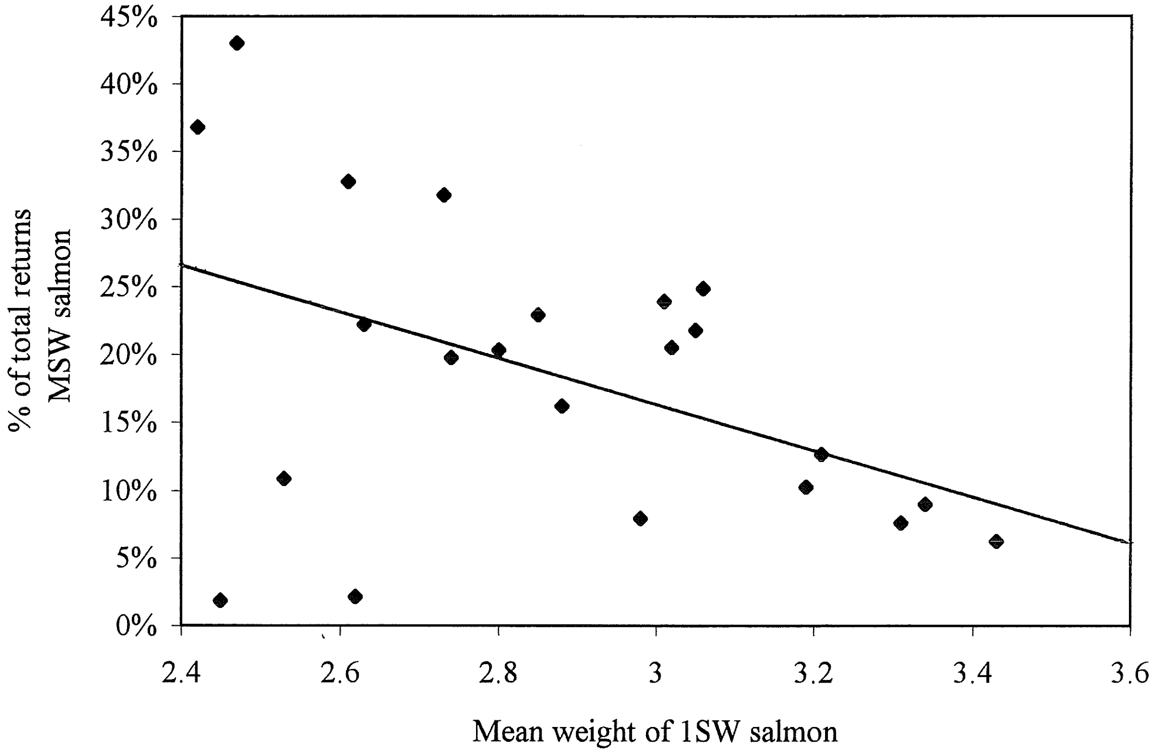


Figure 9.1.2.1. Pre-Fishery abundance estimates of North American salmon, 1974-93. Box plots show 5, 25, 50, 75, and 95% ranges of 200 stochastic realizations.

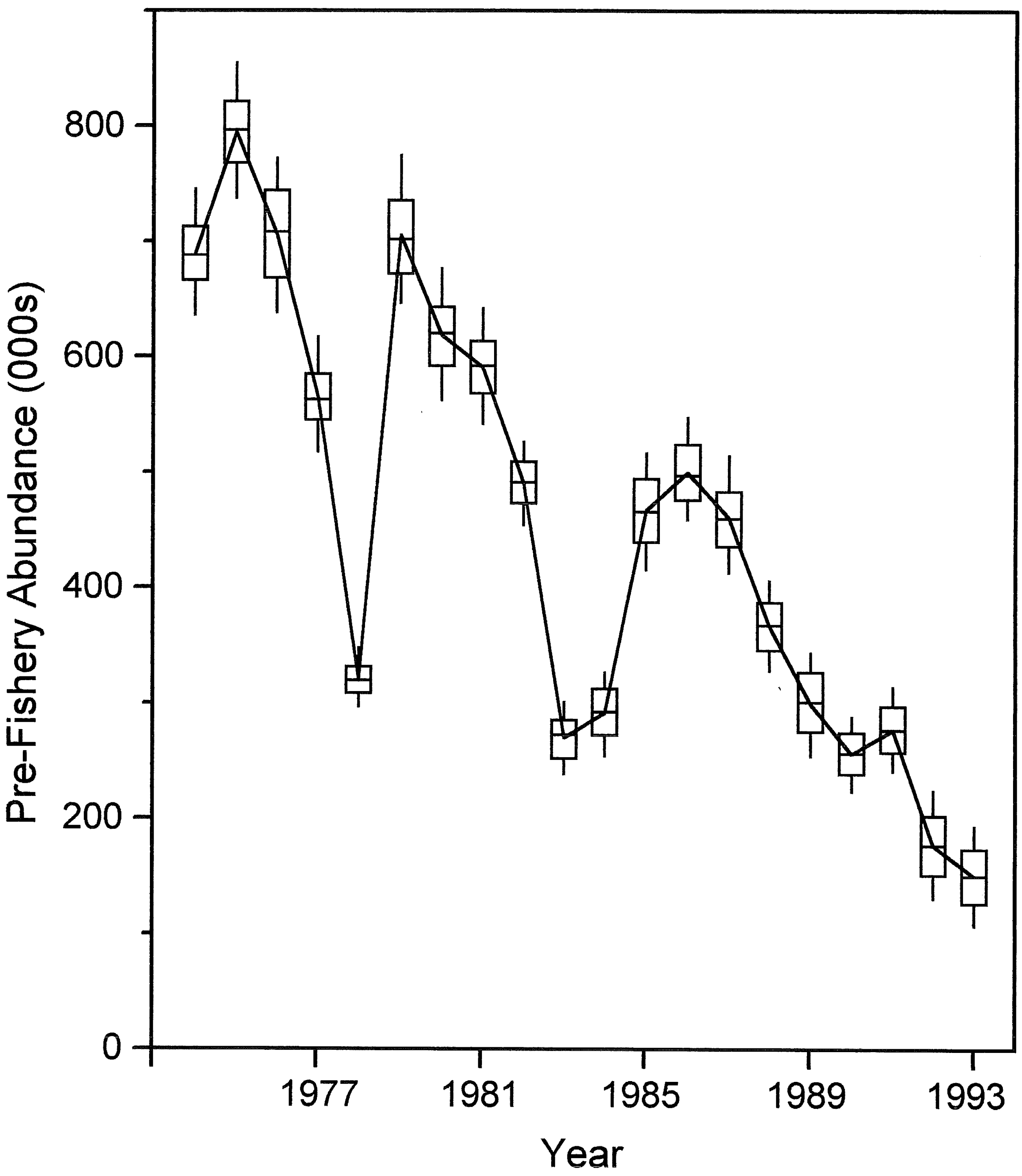


Figure 9.1.3.1. The area of the Labrador Sea used for the determination of suitable overwintering salmon habitat.

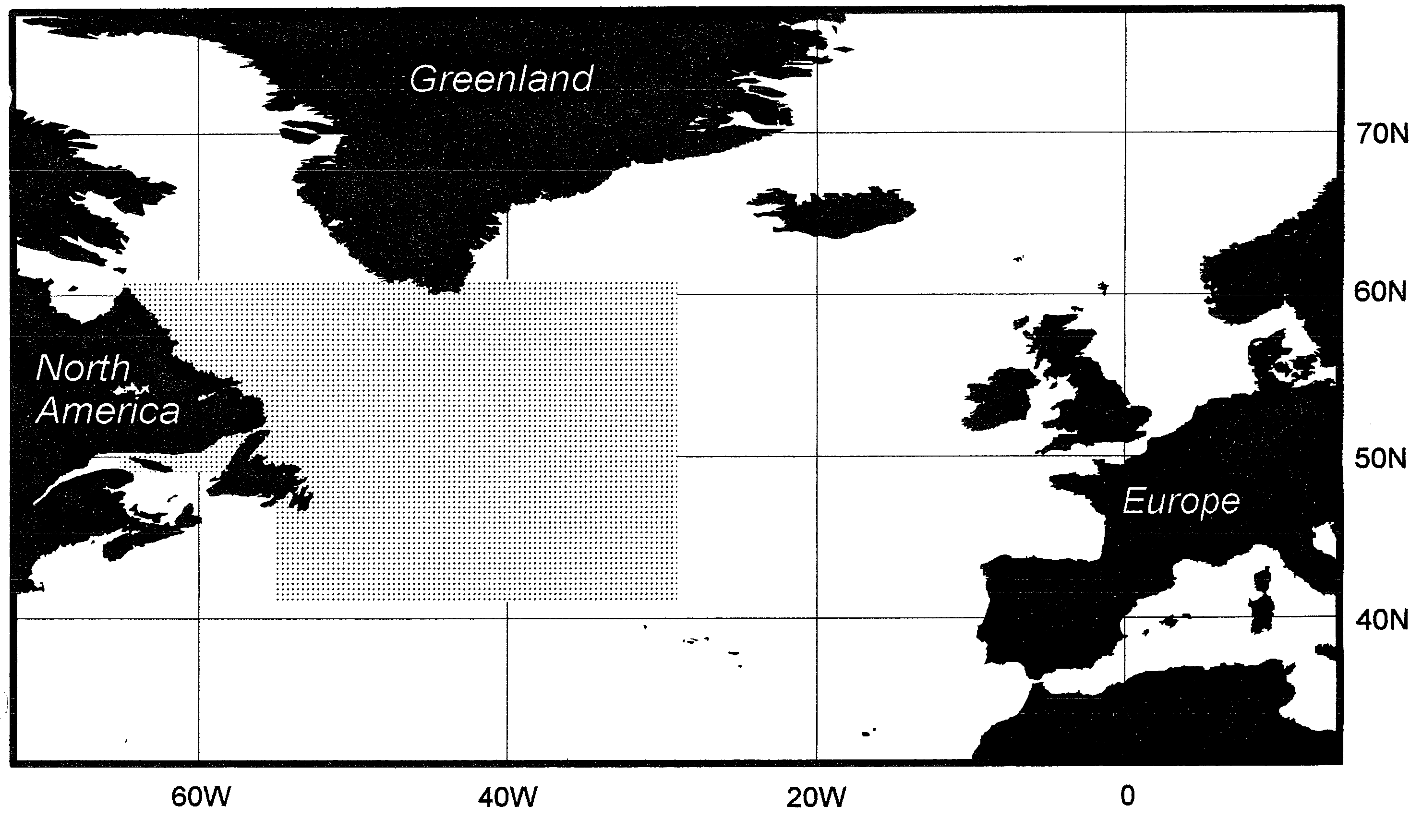


Figure 9.1.3.2. Research vessel catch rates used as weighting factors for potential salmon habtitat in the Labrador Sea, 1965-91.

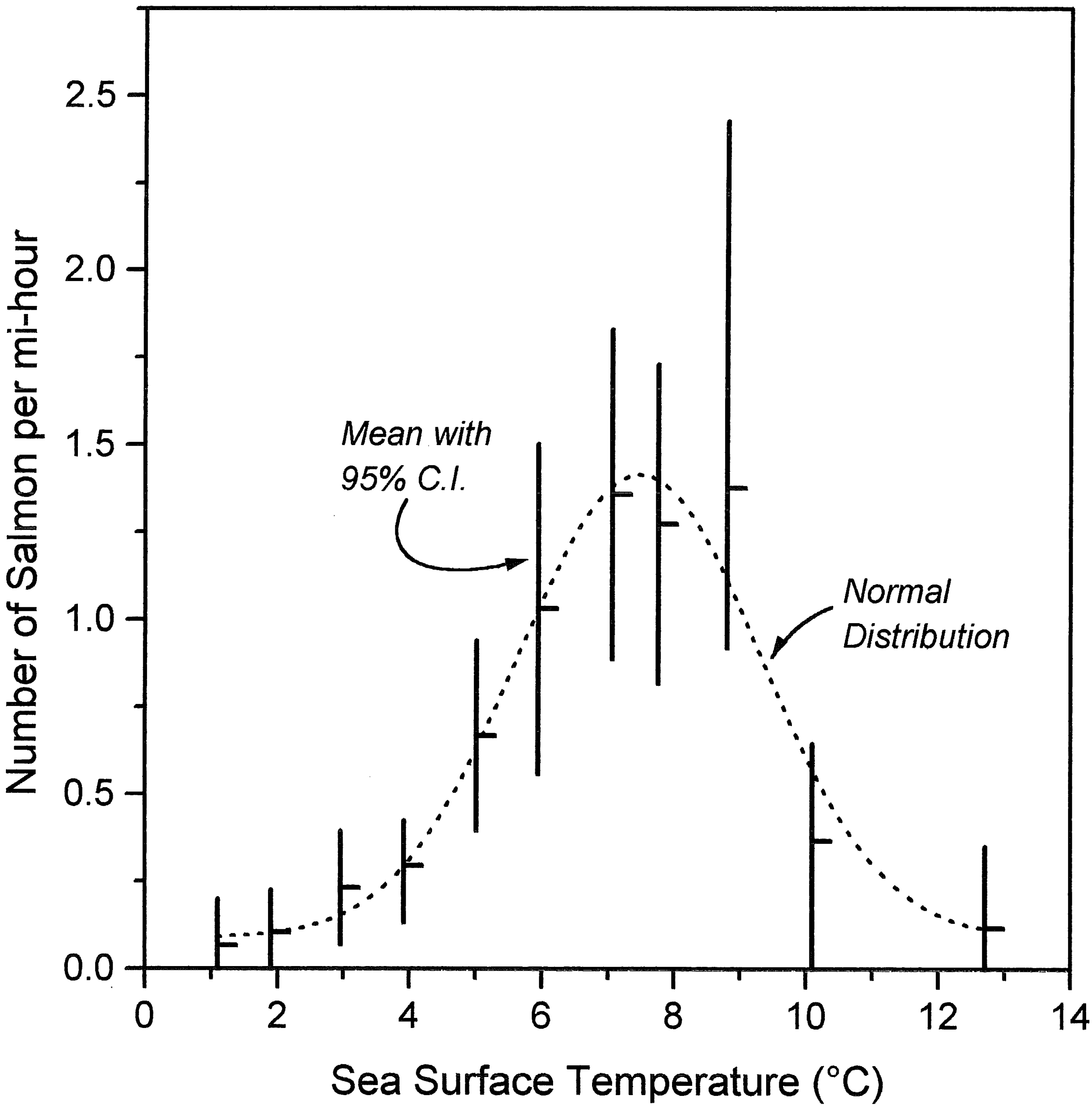


Figure 9.1.3.3 Comparison of thermal habitat values from OI and Blend analyses, 1982-94

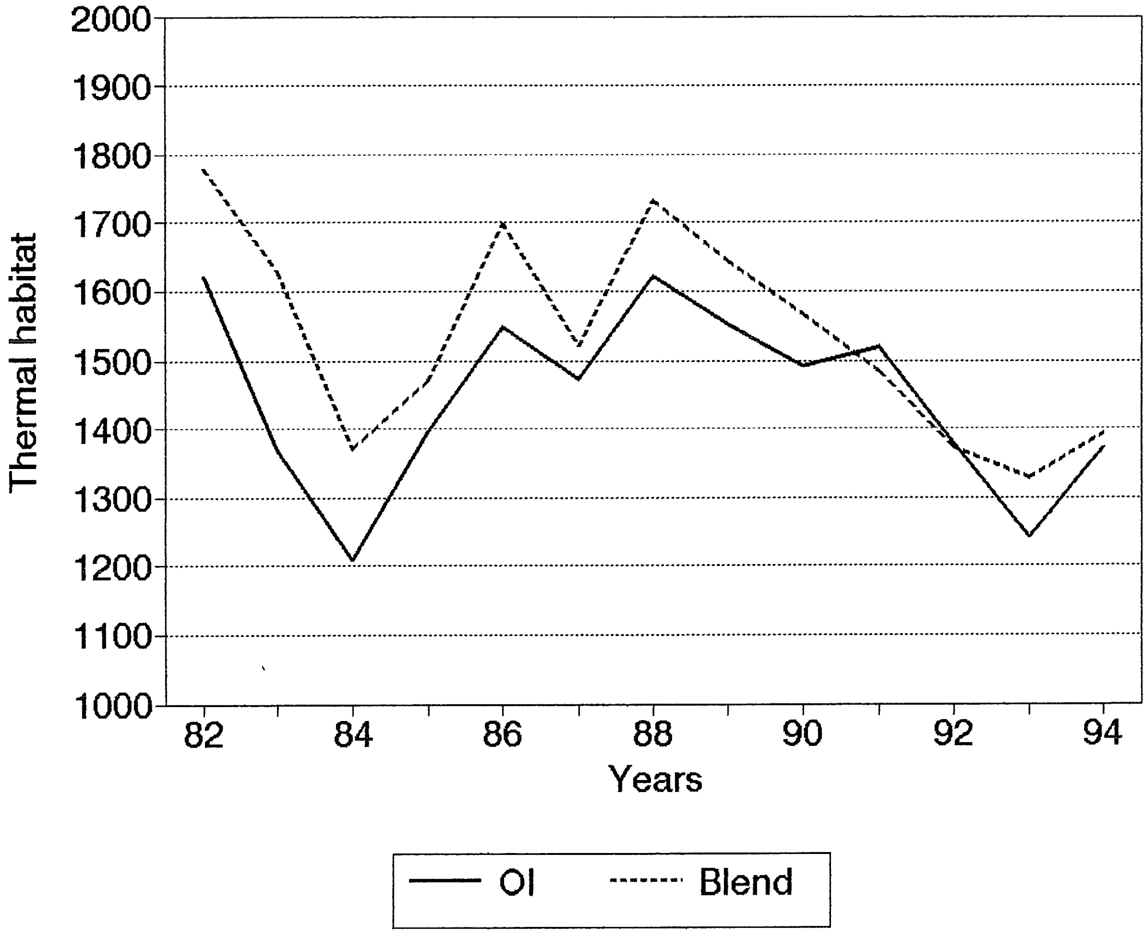


Figure 9.1.4.1 Comparison of March and winter (sum of January, February and March) thermal habitat, 1974-95.

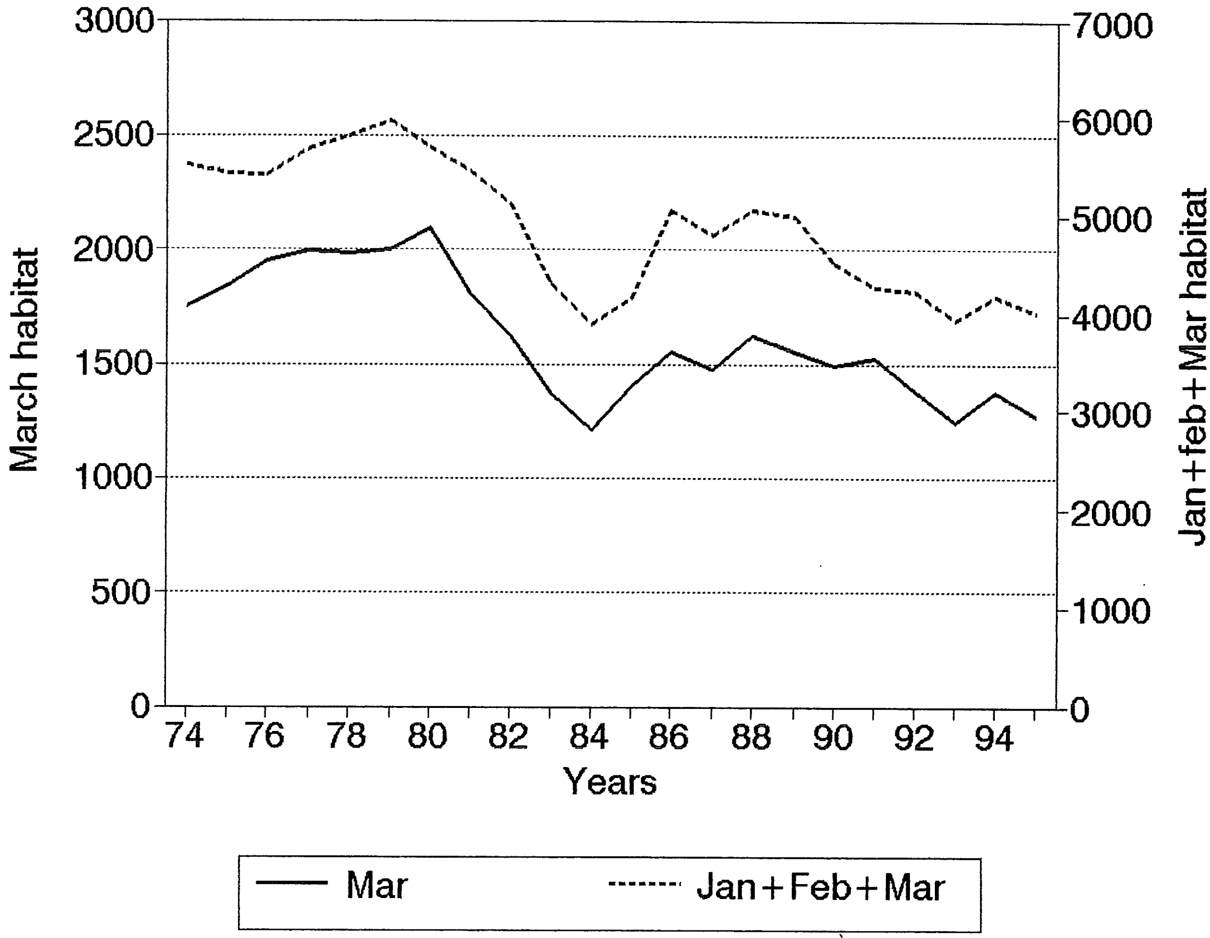


Figure 9.1.4.2 Relationship between winter thermal habitat and pre-fishery abundance, 1974-93

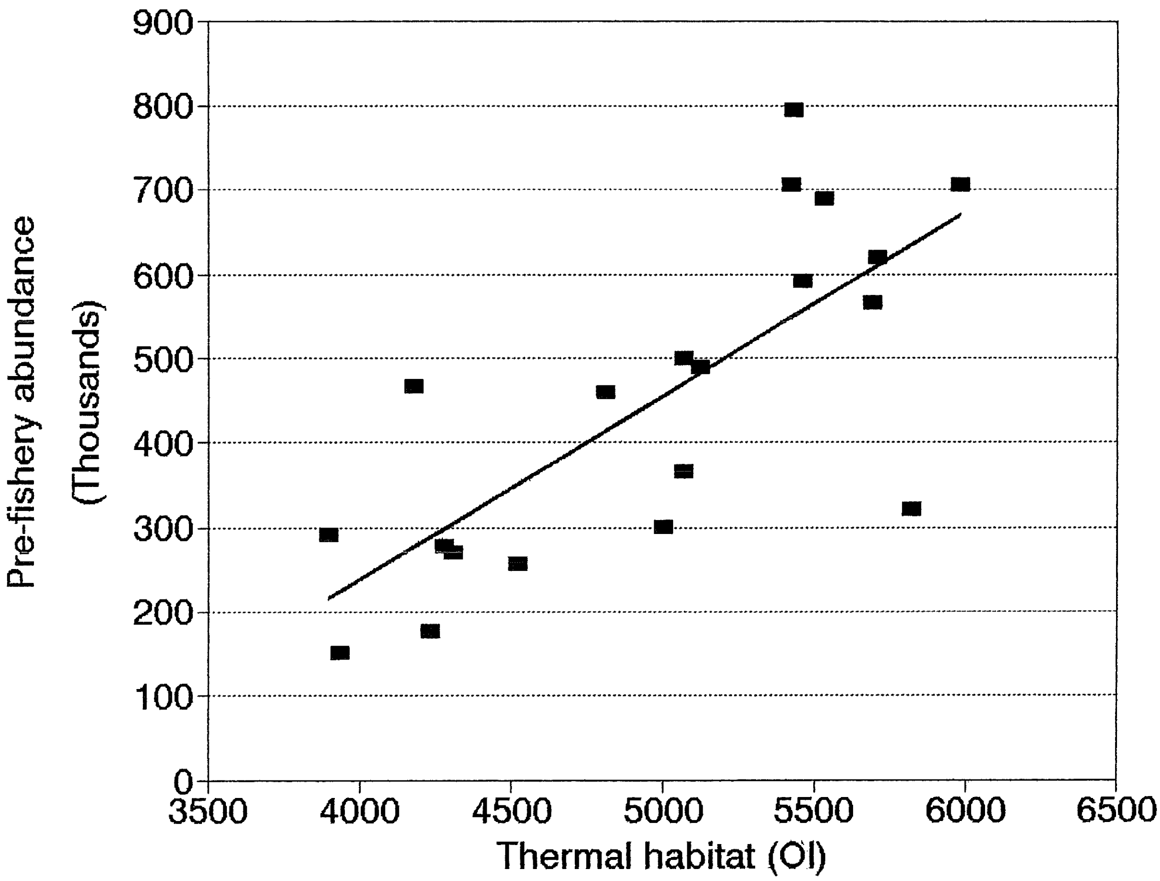


Figure 9.1.4.3 Comparison of the actual, predicted and unbiased predicted pre-fishery abundance values.

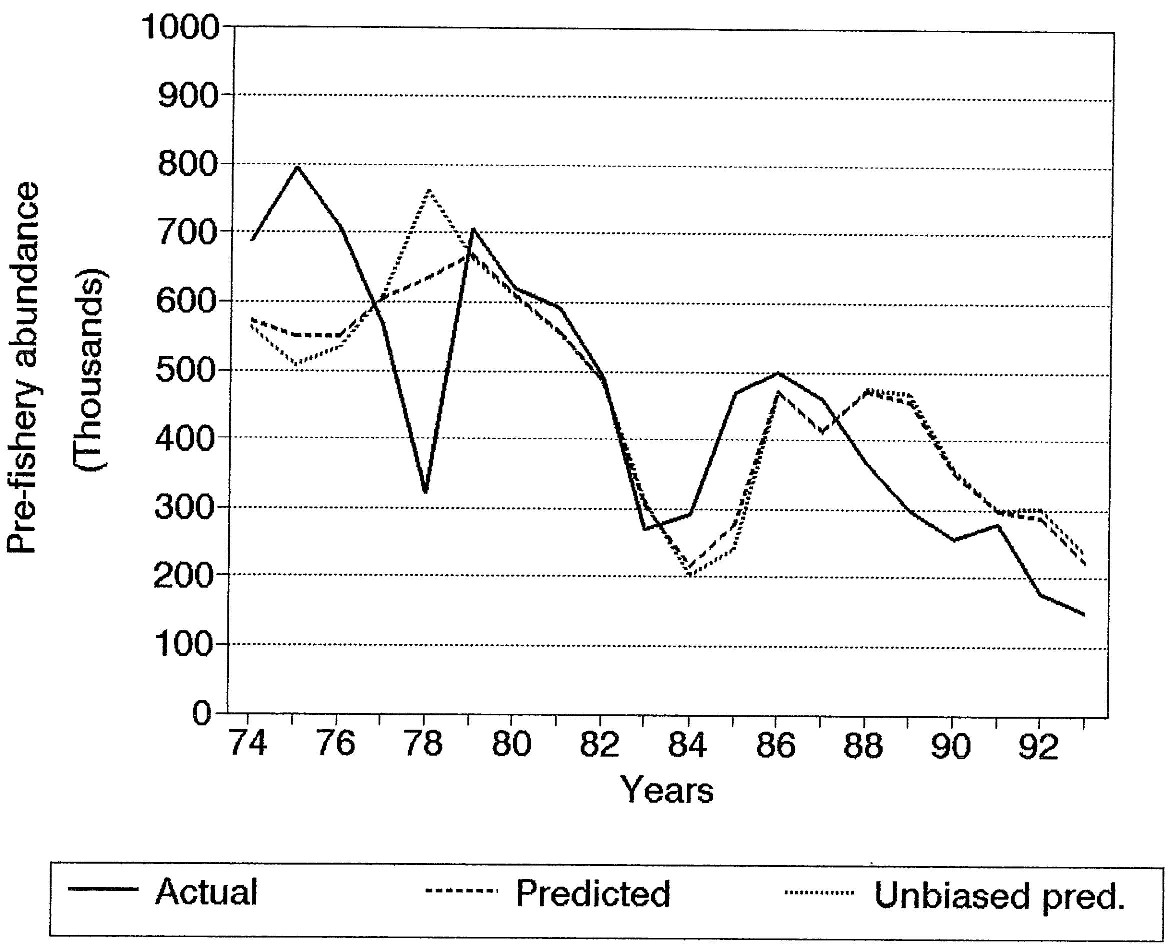


Figure 9.1.4.4 Residual analysis of the pre-fishery abundance regression estimate. A: Residual time series; B: Observed abundance versus residual.

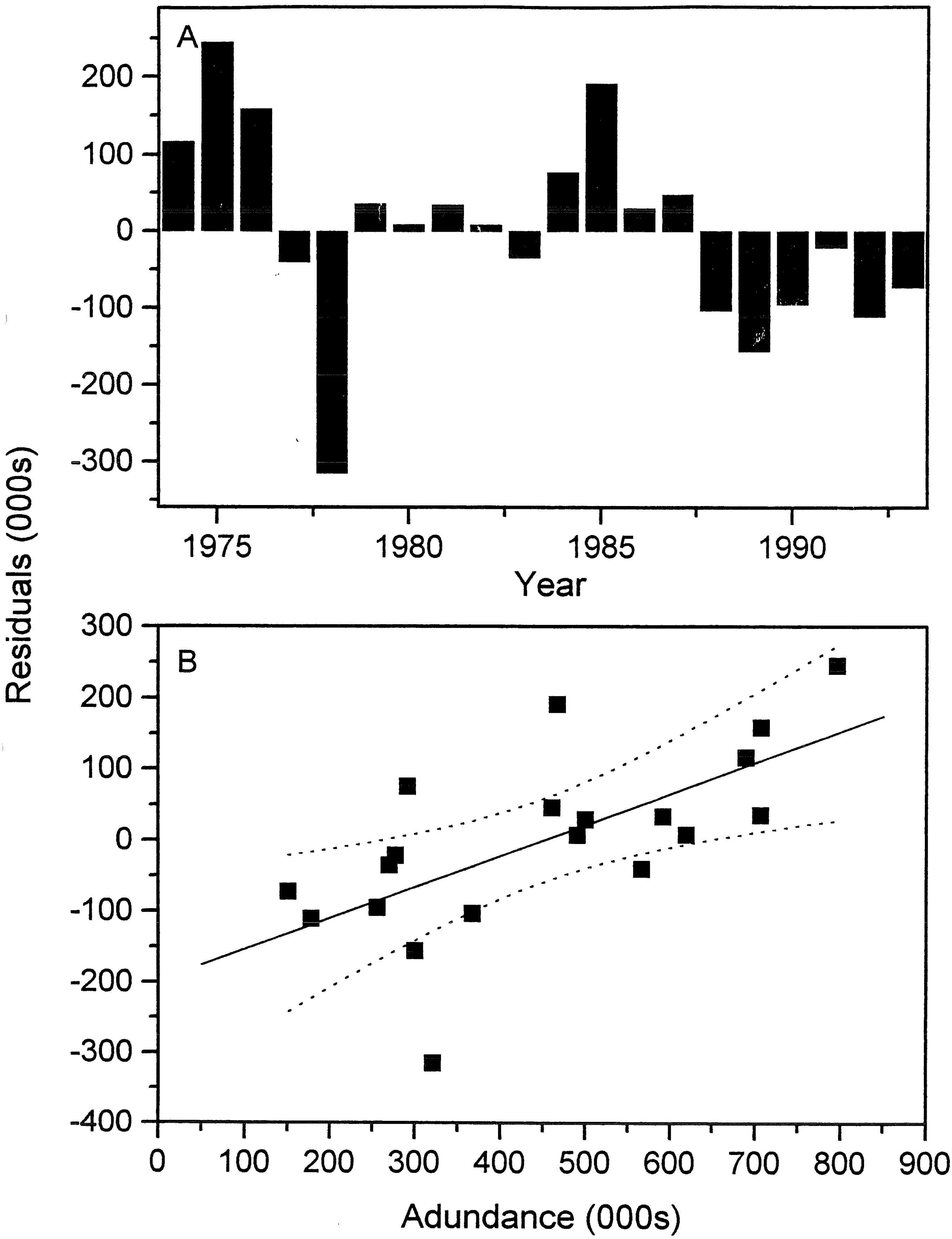


Figure 9.1.5.1 Network for Atlantic salmon stage based projection model.

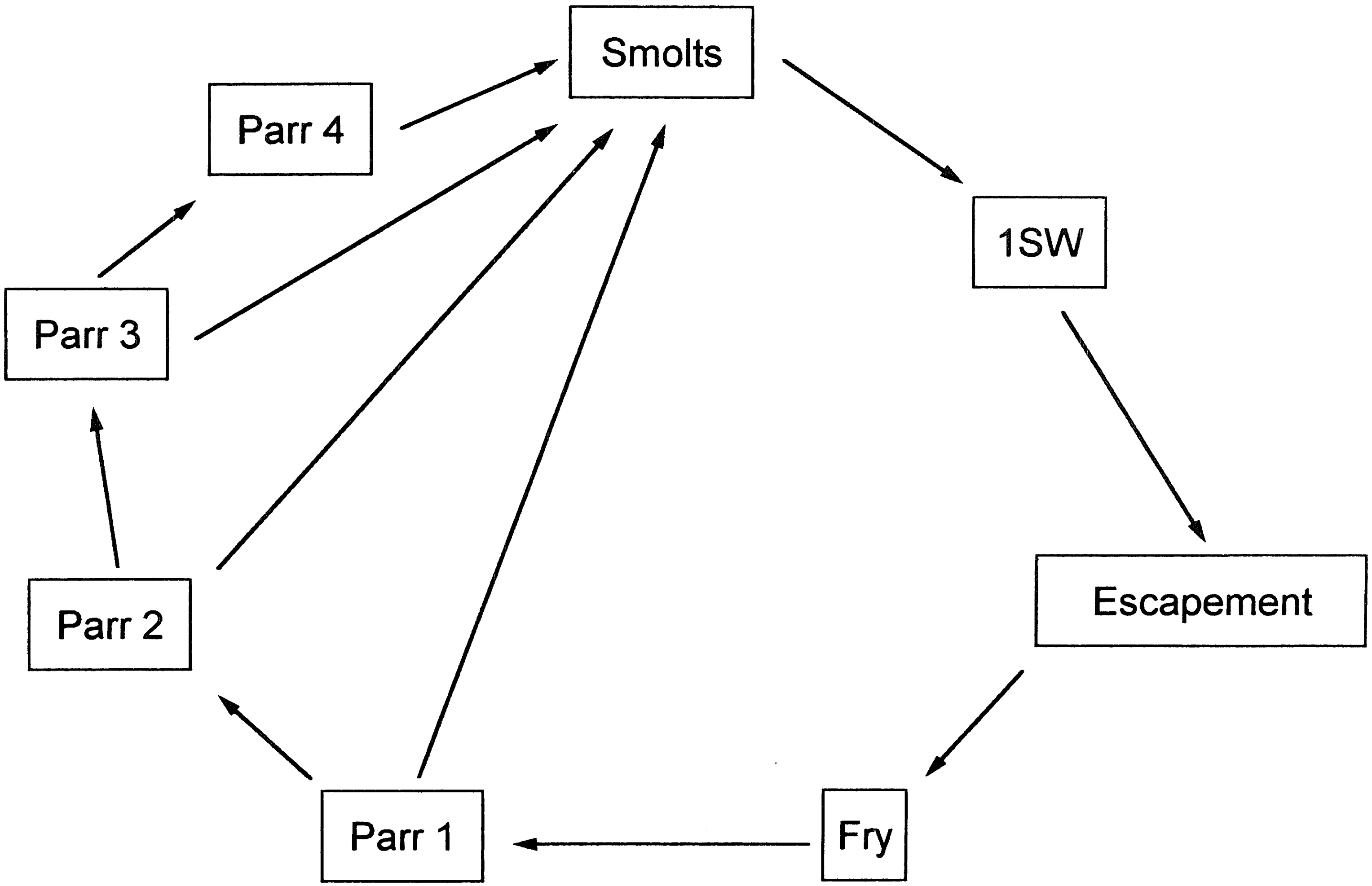


Figure 9.1.5.2 Atlantic salmon projection model. Relationship between spawners and fry production.

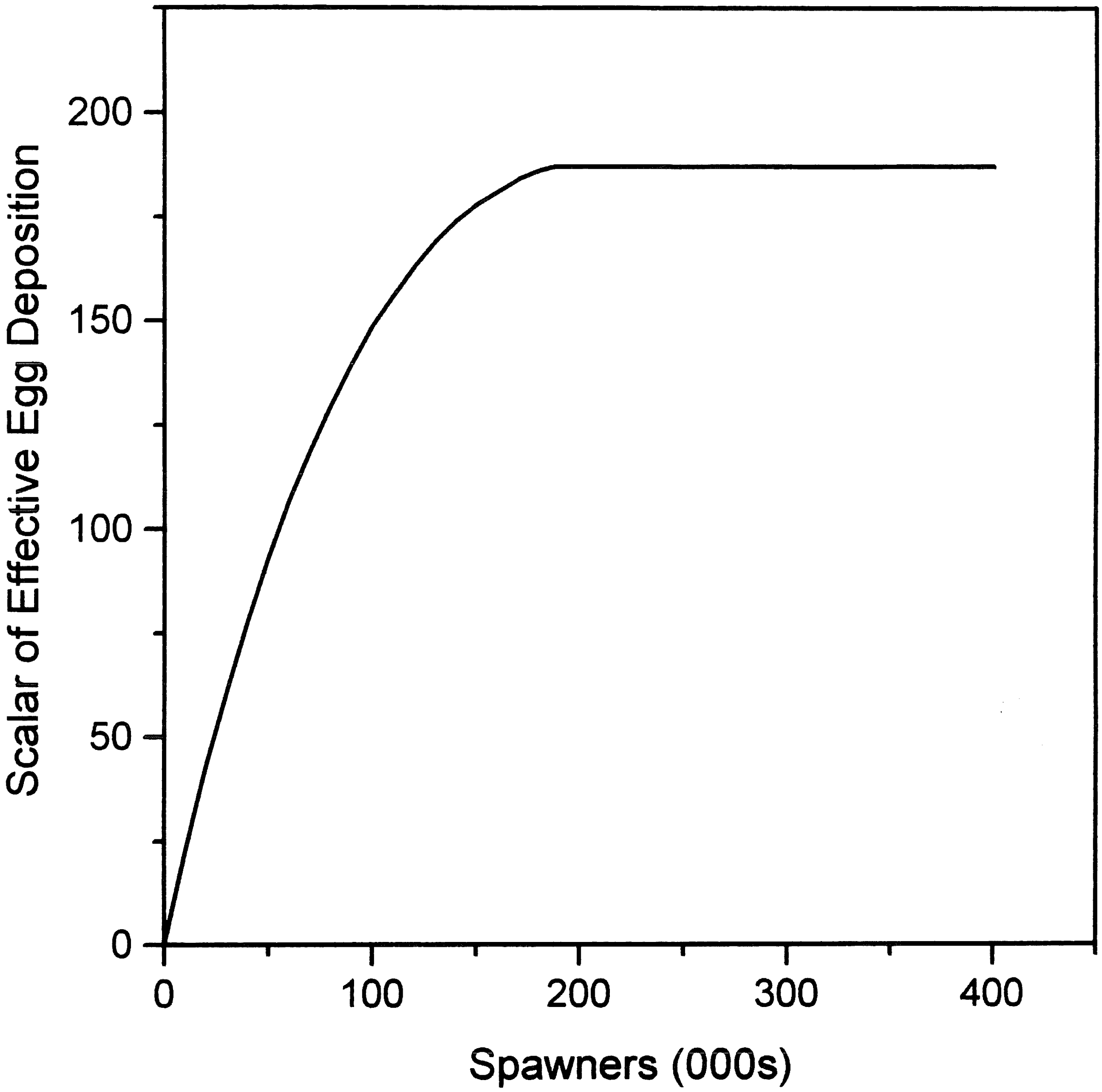


Figure 9.1.5.3 Atlantic salmon projection model. 'Interval' quasi-extinction rates for escapement (i.e. probability of occurrence of a minimum population size over the entire simulation period). Base = baseline model; Fishing = fishing exploitation at 40%; HS = levels of higher stock size.

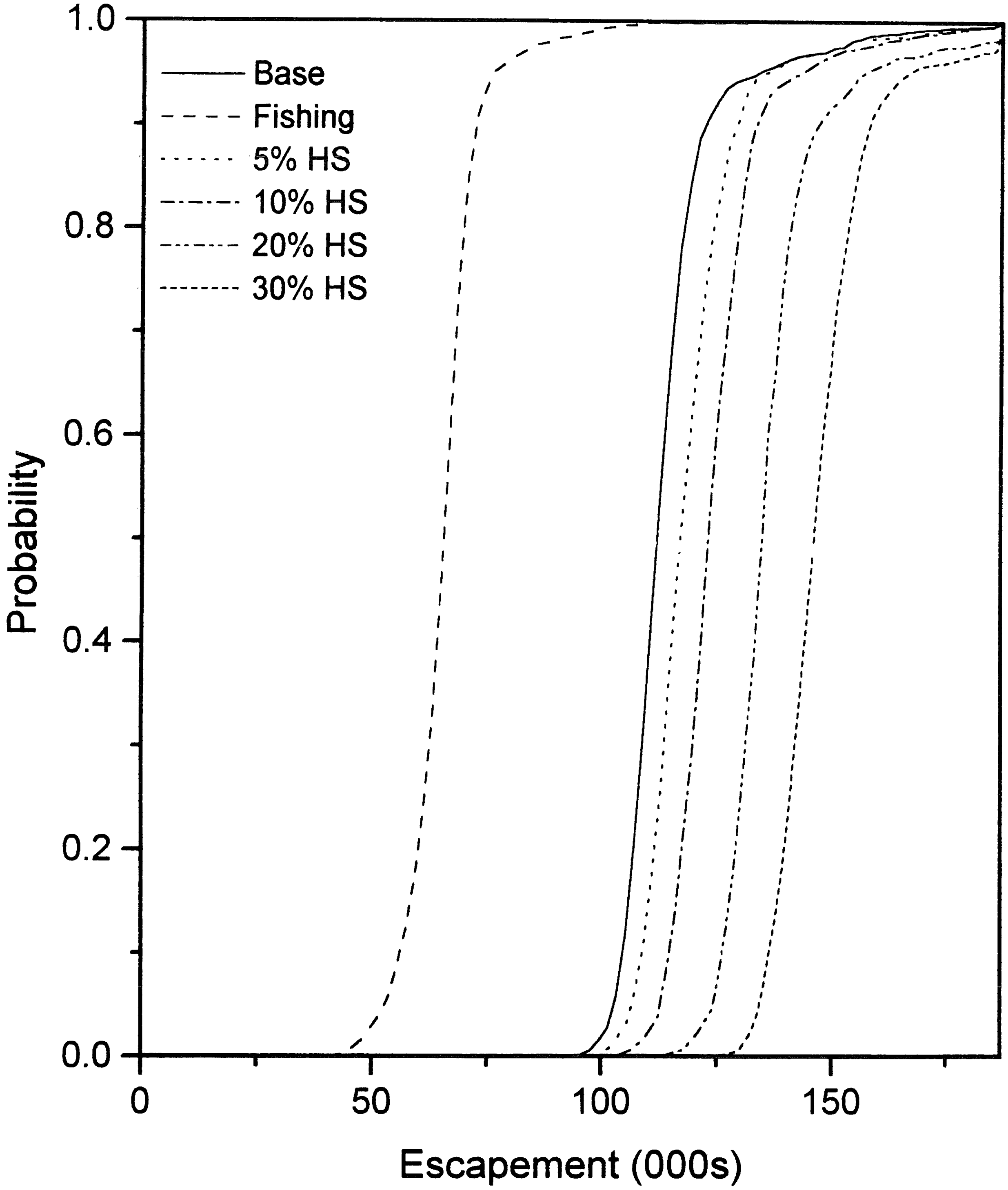


Figure 9.1.5.4 Atlantic salmon projection model. 'Terminal' quasi-extinction rates for escapement (i.e. probability of occurrence of a particular population size at the end of the simulation period). Base = baseline model; Fishing = fishing exploitation at 40%; HS = levels of higher stock size.

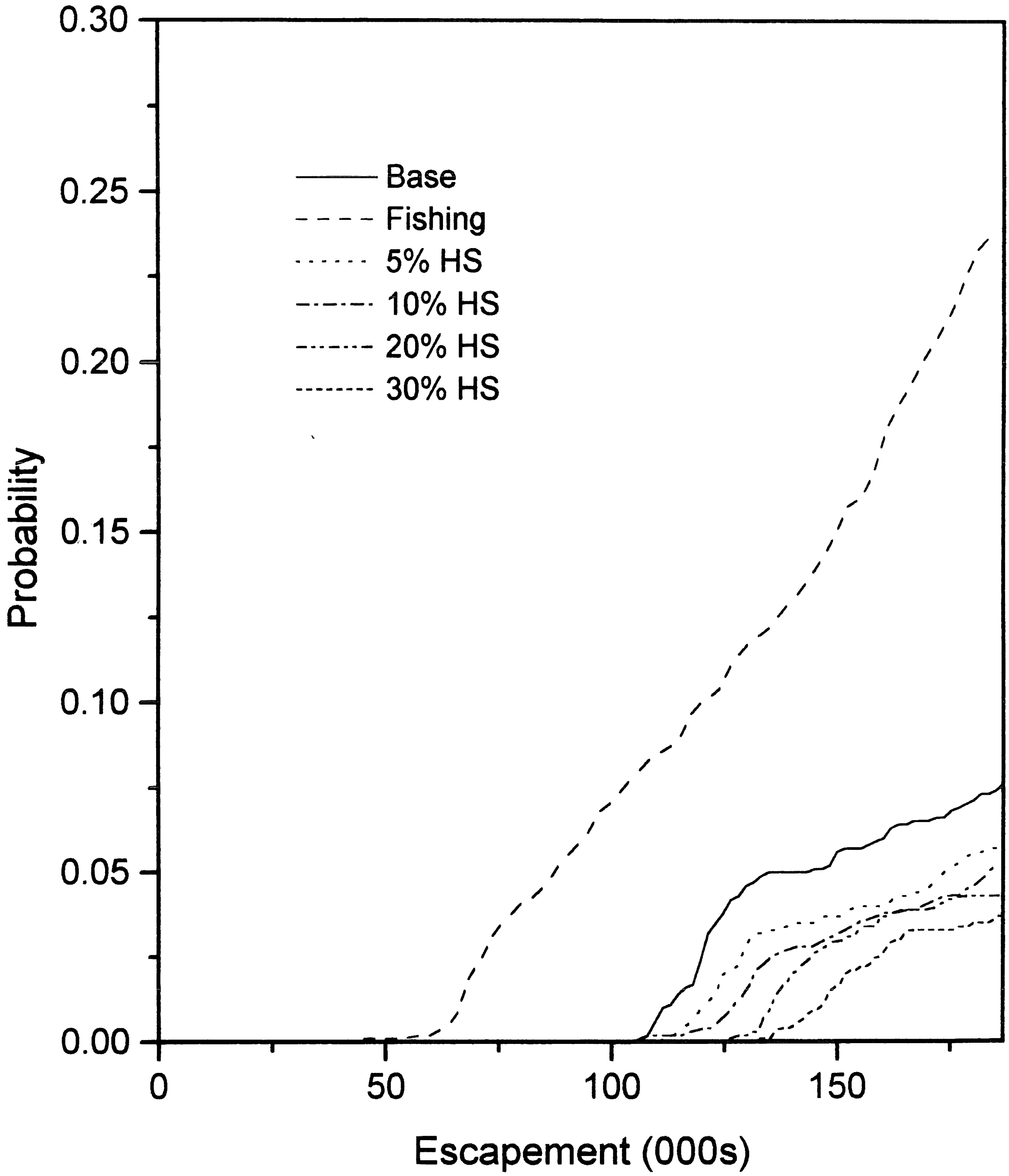


Figure 9.1.5.5 Atlantic salmon projection model. Change in 'interval' quasi-extinction rates with progressive adjustments to stock size.

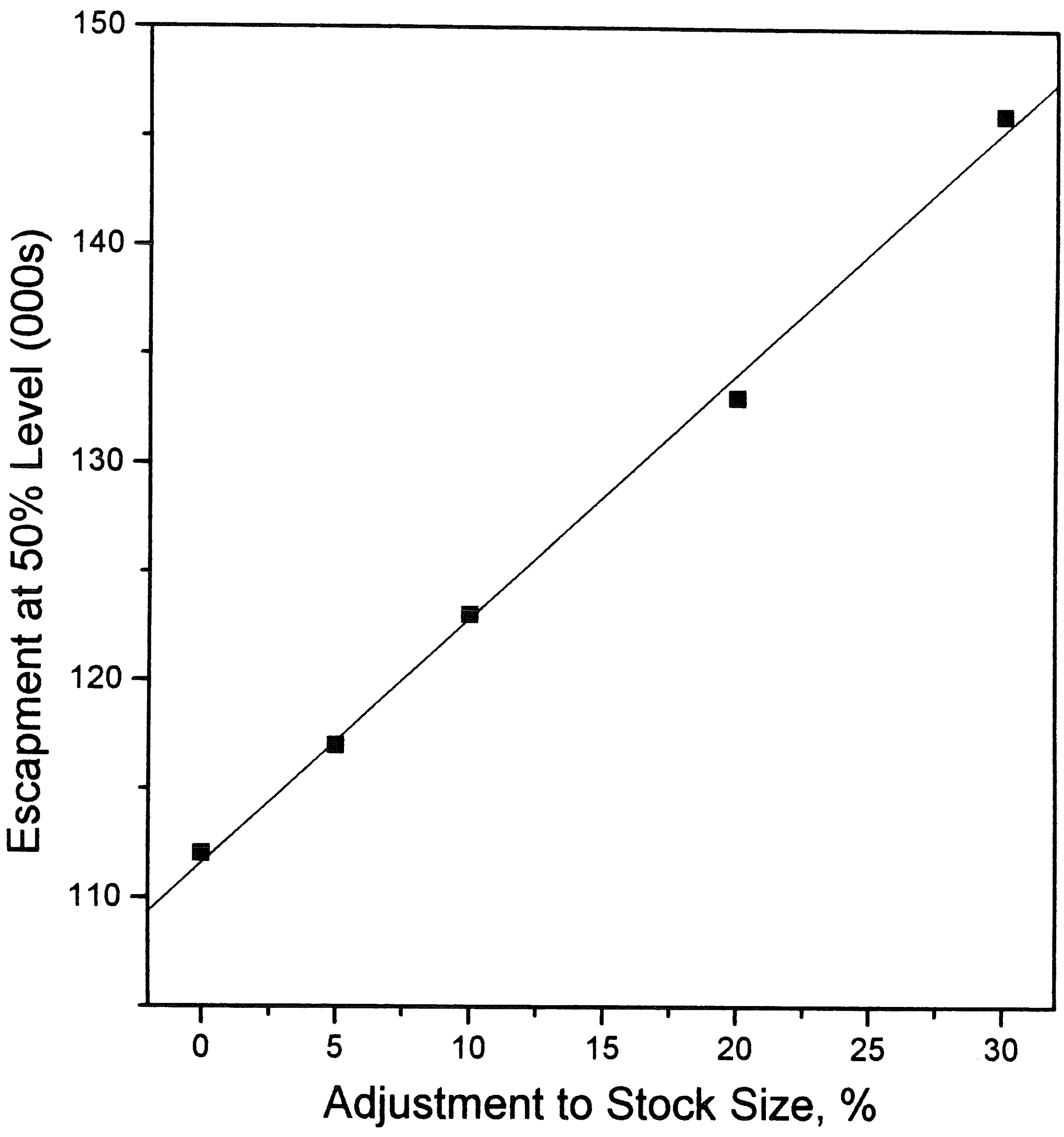


Figure 9.1.5.6 Atlantic salmon projection model. Change in 'terminal' quasi-extinction rates with progressive adjustments to stock size.

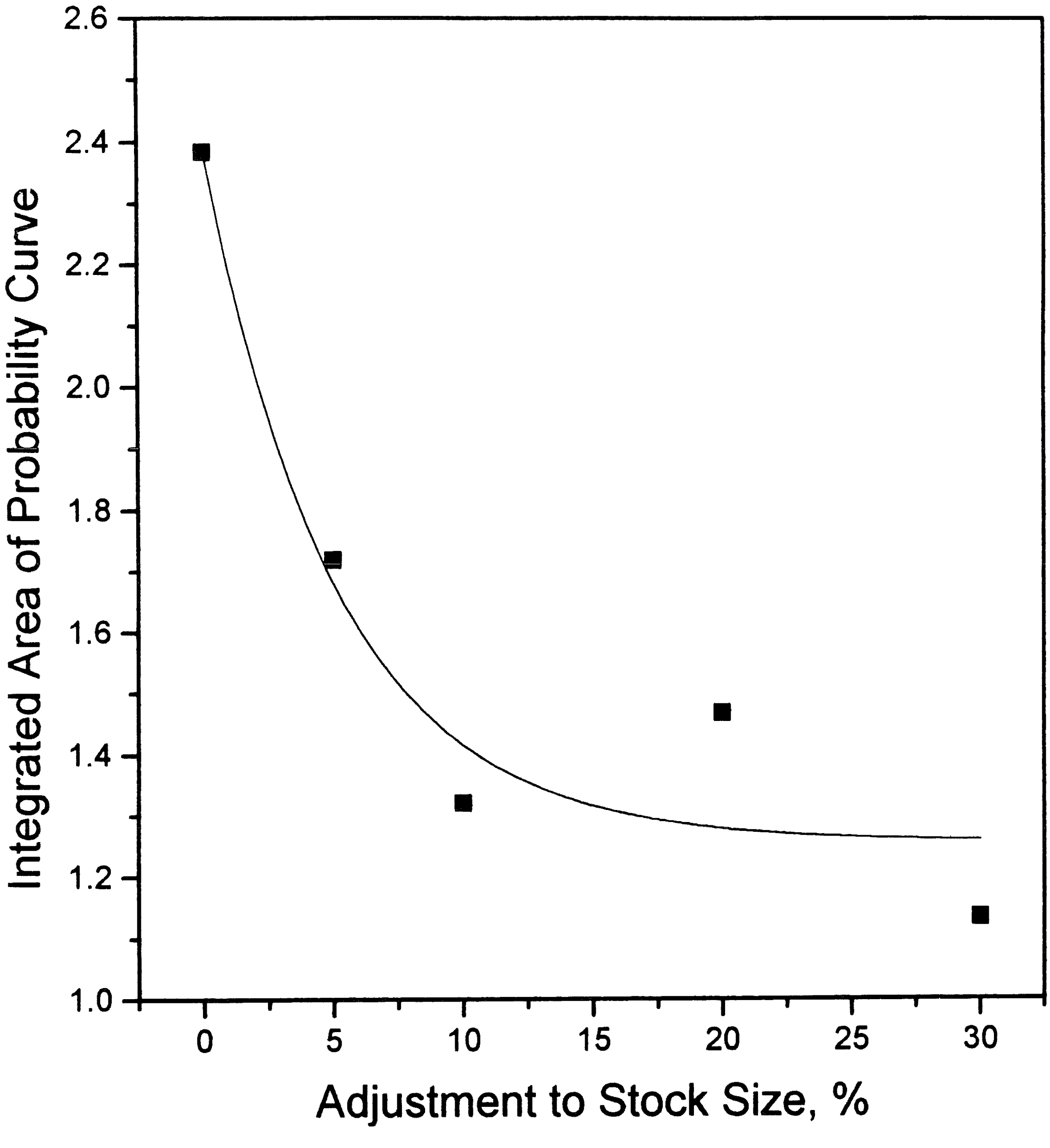
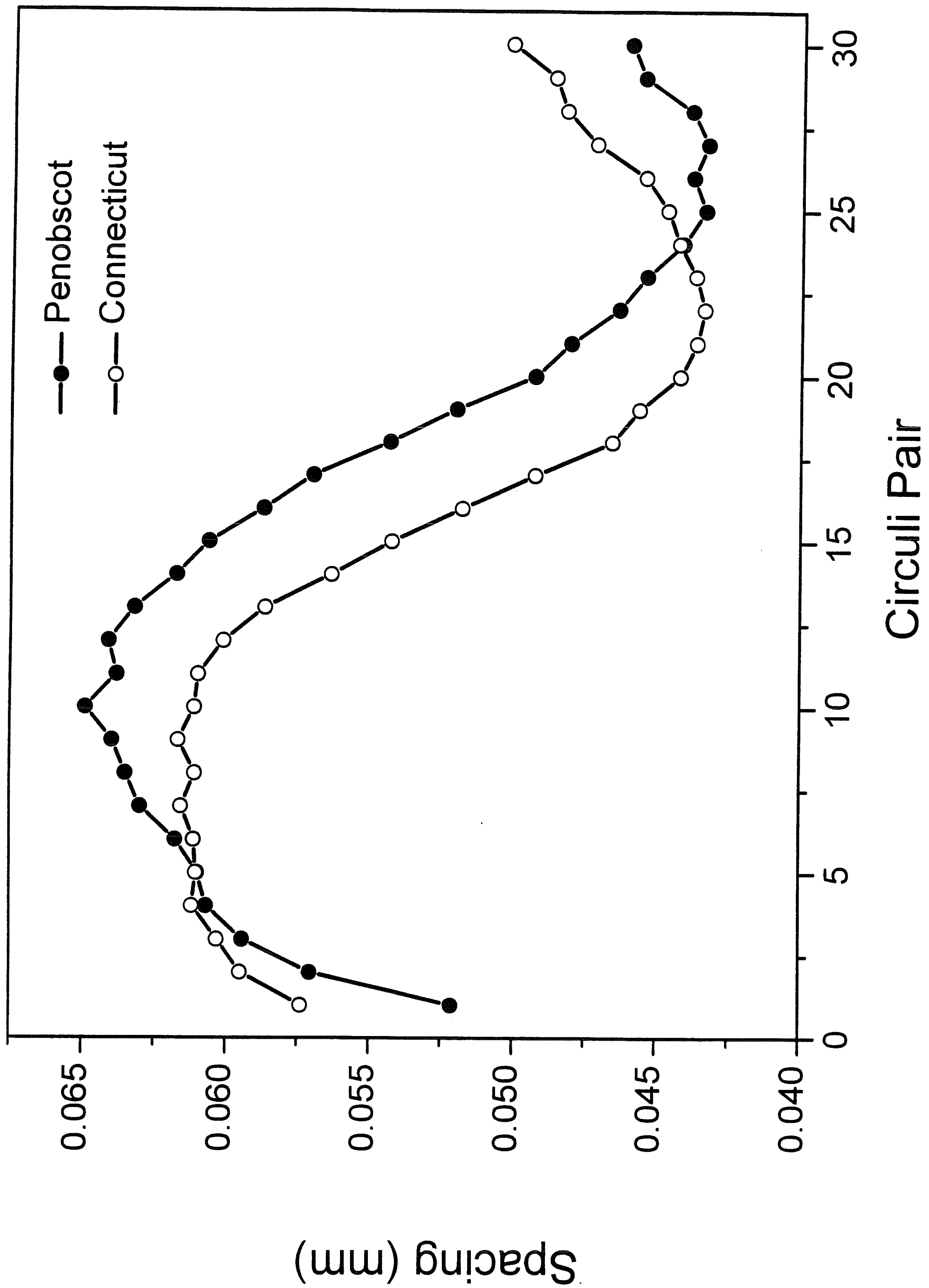


Figure 10.2.1 Grand means of circuli spacing versus circuli pair for 2SW returns to the Penobscot and Connecticut rivers.



APPENDIX 1

TERMS OF REFERENCE FOR THE WORKING GROUP ON NORTH ATLANTIC SALMON , 1995:

Question:	Report section (by NASCO Commission area)		
	NEAC	NAC	WGC
The Working Group on North Atlantic Salmon (Chairman: Mr E.C.E. Potter, UK) will meet at ICES Headquarters from 3-12 April 1995 to:			
a) with respect to Atlantic salmon in each Commission area, where relevant			
i) describe the events of the 1994 fisheries with respect to catches (including unreported catches), gear, effort, composition and origin of the catch (including fish farm escapees and sea-ranched fish) and rates of exploitation,	4.1 4.2	5.1	6.1
ii) describe the status of the stocks (including the contribution to these stocks of fish farm escapees and sea-ranched fish) occurring in the Commission area and, where possible, evaluate spawning escapement against targets,	4.3	5.2	6.2
iii) specify data deficiencies and research needs;	4.4	5.3	6.3
b) evaluate the effects of the following management measures on the stocks and fisheries occurring in the respective Commission areas			
i) quota management measures and closures implemented after 1991 in the Canadian commercial salmon fisheries,		7.1	
ii) the suspension of commercial fishing activity at the Faroes,	7.2		
iii) the suspension of commercial fishing activity at West Greenland;			7.3
c) with respect to the fishery in the West Greenland Commission area			
i) provide catch options, with an assessment of risks, related to the management objective of achieving target spawning escapement,			9.1
ii) review the target spawning level in US rivers in the light of the present condition of the rivers and the stocks;			9.2
d) with respect to fisheries and stocks in the North-East Atlantic Commission area			
i) provide estimates of spawning targets for optimal production.	8.1		
ii) develop methods which could be used in providing advice on catch quotas in relation to stock abundance and, if possible, provide catch options	8.2		
e) report on significant research developments which might assist NASCO with the management of salmon stocks with special reference to			
i) the impacts of fish farm escapees and sea-ranched fish on the wild stocks,	10.1	10.1	10.1
ii) criteria for identifying recruitment overfishing of Atlantic salmon	Nothing to report		
iii) predictive models of annual migration and distribution of Atlantic salmon stock complexes	Nothing to report		
iv) biological (such as maturation, predation, forage base) and environmental (such as oceanographic, productivity) variables which provide interpretation of trends in salmon abundance;	10.2 10.3	10.2 10.3	10.2 10.3
f) with respect to Atlantic salmon in the NASCO area, provide a compilation of microtag, finclip and external tag releases by ICES Member Countries in 1994.	11	11	11
The above terms of reference are set up to provide ACFM with the information required to respond to the request for advice from the North-Atlantic Salmon Conservation Organization.			
A joint half day meeting with the Baltic Salmon and Trout Assessment Working Group will take place at ICES Headquarters on 8 April 1995 to identify questions of mutual interest and to explore possibilities of either merging the two working groups or organising interaction and communication between them.	12	12	12

APPENDIX 2

WORKING DOCUMENTS SUBMITTED TO THE WORKING GROUP ON NORTH ATLANTIC SALMON, 1995

Doc. No. 1	O' Maoileidigh, N., Crozier, W. and Cullen, A. Salmon farm escapees in Irish Commercial Catches -1991 to 1994.
Doc. No. 2	Friedland, K.D., Rago, P.J., Baum, E.T. and Spencer, R.C. Tagging experiments with U.S. origin Atlantic salmon.
Doc. No. 3	Friedland, K.D. and Rago,P.J. Extant and fishery-area exploitation of Maine-origin salmon stocks.
Doc. No. 4	Friedland, K.D., Haas, R.E., and Sheehan, T.F. Post-smolt growth and comparative maturation and survival in two stocks of Atlantic salmon.
Doc. No. 5	Friedland, K.D. A stage-based projection model of North American 2SW salmon stocks.
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APPENDIX 4

JOINT MEETING OF THE WORKING GROUP ON NORTH ATLANTIC SALMON AND THE BALTIC SALMON AND TROUT ASSESSMENT WORKING GROUP.

Report of meeting held at ICES Headquarters, Copenhagen, 8 April, 1995.

At its 1994 Statutory Meeting, ICES resolved (C. Res. 1994 2:6:3 and 2:6:19) that the Working Group on North Atlantic Salmon (NASWG) and the Baltic Salmon and Trout Assessment Working Group (BSTAWG) should meet "to identify questions of mutual interest and to explore possibilities of either merging the two working groups or organising interactions and communication between them".

The two Working Groups met at ICES Headquarters, Copenhagen, on Saturday 8 April under the chairmanship of Mr E C E Potter, Chairman of the Working Group on North Atlantic Salmon, to address these questions. The Chairman of ACFM and the ICES Fisheries Secretary also attended the meeting.

The Chairman of ACFM was asked to explain the rationale behind the terms of reference for the meeting. He pointed out that ICES Working Groups had moved towards area-based groups rather than species-based groups because of the growing awareness of the importance of the interactions between species and fisheries. However, it was clear that the tasks assigned to the BSTAWG did not fit readily into the work of the main Baltic Group and those assigned to the NASWG did not readily fit into the work of any of the other Working Groups. ACFM considered that these two Working Groups shared many similarities in the type of assessment work they were called upon to do and that the tasks might be addressed more efficiently if the groups were to merge. At the very least, there should be attempts made to co-ordinate the activities of the groups to avoid duplication of effort.

The Meeting considered a number of areas of common concern to the two Working Groups including:

a) Spawning stock targets, MBAL
b) Common trends in production, survival, etc of stocks in different areas
c) Predictive population modelling (run-reconstruction, environmental models)
d) Studies of salmon in the sea (e.g. tracking)
e) Effects of reared fish on wild stocks, including enhancement issues (e.g. genetic, ecological and fishery effects)

It was clear that the problems faced by the two groups include both similarities and differences. Clearly, the basic biology of the fish is similar in the two areas. However, in the Baltic, the fishery is based on reared fish but attempts must be made to safeguard the few remaining wild stocks, many of which are at very low levels. In the Atlantic, the fisheries are based on wild stocks, although activities such as enhancement, ranching and farming have introduced increasing complications for management in recent years. In the Baltic, it has been possible to use traditional VPA methods to assess population sizes in the sea but this is not possible for salmon in the North Atlantic because of basic differences in the migratory behaviour of these fish and the fisheries operating on them compared with Baltic salmon. Accordingly, alternative models have been developed to assess pre-fishery abundance levels for salmon in the Atlantic Ocean. Run-reconstruction models are used in both areas but these are tailored to the particular features of the fisheries. Thus, although some of the problems are the same, it has been necessary to develop and adopt different assessment methods which are not all transferable between the two Working Groups. Nevertheless, it was felt that the two groups had much to learn from each other.

The questions of merging the two Working Groups or forming some sort of closer co-operation between them were considered. The Chairman of ACFM said that advice relating to salmon stocks and fisheries was provided to both the North Atlantic Salmon Conservation Organisation (NASCO) and the International Baltic Sea Fisheries Commission (IBSFC). Although NASCO deals only with salmon and IBSFC deals with salmon, herring, sprats and cod in the Baltic, the type of advice requested from ACFM by the two organisations was similar.

The two Working Groups on salmon are large, particularly the NASWG; the new Group would be the largest ICES Assessment Working Group. In order to give every member of a large group adequate time to contribute at plenary sessions, it would be necessary to have even longer meetings or reduce the time during which sub-groups do their assessment work. Either way, it was felt that this would certainly not lead to greater efficiency than is already shown by the existing Working Groups. It was recognised that the workloads of the two

Working Groups would certainly not decrease and would probably increase. In this case, any reduction in the numbers of members attending meetings would impair the ability of a joint Working Group to complete its tasks and to provide ACFM with good quality assessments. It was noted that within the NASWG, three sub-groups were established to address questions relating to the three NASCO Commission Areas (North America, West Greenland and North East Atlantic). The report of the NASWG was structured to address the questions from NASCO relevant to the different Commission areas. If the two Working Groups were to merge, it would mean that the new Working Group would require at least four sub-groups and the structure of the report would have to change, effectively being divided into two independent sections on the separate stock complexes in the North Atlantic and the Baltic. Finally, the assessments performed by the NASWG are all co-dependent because the catches relate to a common pool of stocks. The same is true of the BSTAWG and stocks in their area. However, the only common thread between the two groups is methodology . Thus, a merged group would perform separate, unrelated assessments. This would be inconsistent with the rationale in which Working Groups are being formed, that is for area-based groups where interactions between stocks occur.

The meeting agreed that:

1. they did not wish the Working Groups to merge at this time but that it would be desirable to improve communication on methodologies;

2. it would be desirable to arrange occasional join sessions of the two Working Groups to address common problems and to exchange information on topics such as spawning targets. Such sessions could be arranged by holding the meetings at the same time in Copenhagen, although efforts should be made to ensure that the meetings did not end on the same day;

3. *ad hoc* Study Groups or Workshops should be convened occasionally to permit specific topics to be addressed more fully, however, such meetings should not be held simultaneously or concurrently with the Working Group meetings;

4. efforts should be made to improve communication on the work of the two group, and it would be useful if members of both groups received copies of both Working Group reports;

5. dissemination and joint discussion of scientific papers of interest to both groups should be encouraged, particularly through participation in ANACAT meetings.

APPENDIX 5

COMPUTATION OF CATCH ADVICE FOR WEST GREENLAND

The North American Spawning Target (SpT) for 2SW salmon has been revised to 186,486 fish in 1995.

This number must be divided by the survival rate for the fish from the time of the West Greenland fishery to their return of the fish to home waters (11 months) to give the Spawning Target Reserve (SpR). Thus:

Eq. 1. $SpR = SpT * (exp(11*M)$ (where $M = 0.01$)

The Maximum Allowable Harvest (MAH) may be defined as the number of non-maturing 1SW fish that are available for harvest. This number is calculated by subtracting the Spawning Target Reserve from the pre-fishery abundance (PFA).

Eq. 2. $MAH = PFA - SpR$

To provide catch advice for West Greenland it is then necessary to decide on the proportion of the MAH to be allocated to Greenland (f_{NA}). The allowable harvest of North American non-maturing 1SW salmon at West Greenland NA1SW) may then be defined as

Eq. 3. $NA1SW = f_{NA} * MAH$

The estimated number of European salmon that will be caught at West Greenland (E1SW) will depend upon the harvest of North American fish and the proportion of the fish in the West Greenland fishery that originate from North America [PropNA] Because there are no new data on fish caught at West Greenland, the same value of PropNA has been used as in 1994. Thus

Eq. 4. $E1SW = (NA1SW / PropNA) - NA1SW$

To convert the numbers of North American and European 1SW salmon into total catch at West Greenland in metric tonnes, it is necessary to incorporate the mean weights of salmon for North America [WT1SWNA] and Europe [WT1SWE] and an adjustment for the age composition of the catch [ACF]. The quota (in tonnes) at Greenland is then estimated as

Eq. 5. $Quota = (NA1SW * WT1SWNA + E1SW * WT1SWE) * ACF/1000$

where

WT1SWNA =	mean weight (kg) of North American salmon at Greenland, the 1994 value was forecasted as described below
WT1SWE =	mean weight (kg) of European salmon at Greenland, the 1994 value was forecasted as described below
ACF =	age correction factor for multi-sea winter salmon at Greenland based on the total weight of salmon caught divided by the weight of 1SW salmon.

As no new data are available on fish at West Greenland, the same value of mean weights by continent [WT1SWNA, WT1SWE] and the age correction factor [ACF] have been used as in 1994.

APPENDIX 6

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